USAFOEHL REPORT

88-139EH0086KNA

AD-A203 708

COMPREHENSIVE NOISE SURVEY IN DEPOT ARMAMENT REPAIR, BUILDING 509, HILL AFB UT

TERRY M. FAIRMAN, Captain, USAF, BSC

October 1988

Final Report

Distribution is unlimited; approved for public release

USAF Occupational and Environmental Health Laboratory
Human Systems Division (AFSC)
Brooks Air Force Base, Texas 78235-5501

NOTICE

When Government drawings, specifications, or other data are used for any purpose other than a definitely related Government procurement operation, the Government incurs no responsibility or any obligation whatsoever. The fact that the Government may have formulated, or in any way supplied the drawing, specifications, or other data, is not to be regarded by implication, or otherwise, as in any manner licensing the holder or any other person or corporation; or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

The mention of trade names or commercial products in this publication is for illustration purposes and does not constitute endorsement or recommendation for use by the United States Air Force.

The Public Affairs Office has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nations.

This report has been reviewed and is approved for publication.

Terry M. Fairman

TERRY M. FAIRMAN, Capt, USAF, BSC
Consultant, Industrial Hygiene Engineer

Shelton R. Birch

SHELTON R. BIRCH, Colonel, USAF, BSC
Chief, Consultant Services Division

Air Force installations may direct requests for copies of this report to: USAF Occupational and Environmental Health Laboratory (USAFOEHL) Library, Brooks AFB TX 78235-5501.

Other Government agencies and their contractors registered with the DTIC should direct requests for copies of this report to: Defense Technical Information Center (DTIC), Cameron Station, Alexandria VA 22304-6145.

Non-Government agencies may purchase copies of this report from: National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield VA 22161

James C. Rock

JAMES C. ROCK, Colonel, USAF, BSC
Commander

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

AD-A203 ...

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS N/A
2a. SECURITY CLASSIFICATION AUTHORITY N/A 2b. DECLASSIFICATION / DOWNGRADING SCHEDULE N/A	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release. Distribution is unlimited.
4. PERFORMING ORGANIZATION REPORT NUMBER(S) 88-139EH0086KNA	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION USAF Occupational and Environmental Health Laboratory 6b. OFFICE SYMBOL (If applicable) ECH	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) Brooks AFB TX 78235-5501	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING / SPONSORING ORGANIZATION Same as 6a 8b. OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code) Same as 6c	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO / WORK UNIT ACCESSION NO

11. TITLE (Include Security Classification)
Comprehensive Noise Survey in Depot Armament Repair, Bldg 509, Hill AFB UT

12. PERSONAL AUTHOR(S)
Terry M. Fairman, Capt, USAF, BSC

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM ______ TO ______	October 1988	137

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Noise, Reverberation Times, Noise Abatement, Noise Control

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Reverberation measurements were made in several rooms of the newly constructed Depot Armament Repair building at Hill AFB UT. An evaluation of the benefits of increasing each room's absorption was then made by determining the room constant for each room. Findings indicated additional acoustic absorption in several of the rooms would effectively reduce the amount of reverberent energy present. Recommendations are also provided for control of specific noise sources in each room.

20 DISTRIBUTION / AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Capt Terry M. Fairman	22b. TELEPHONE (Include Area Code) (512) 536-3214/AV 240 22c OFFICE SYMBOL USAFOEHL/ECH

DD Form 1473, JUN 86 Previous editions are obsolete. SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

ACKNOWLEDGMENTS

The author wishes to gratefully acknowledge the assistance of Major John C. Ellis, II, USAFOEHL/ECH, during the data collection phase of this survey. The cooperation and assistance of the Maintenance Directorate at Hill AFB, particularly Mr Gerald Betournay, supervisor of the aircraft ordnance repair section, and Mr David Gange, OO-ALC/MANE, is gratefully appreciated. Finally, the author recognizes the support and assistance of the Bioenvironmental Engineering staff at Hill AFB, whose efforts in pre-coordinating this survey made everything go smoothly.

Contents

I. INTRODUCTION

A. Purpose

This report presents the findings and recommendations of a comprehensive noise survey performed in the new depot armament repair building (Bldg 509) at Hill AFB on 14 and 15 Jun 88. The data presented in this report support the acquisition and installation of necessary engineering controls in Bldg 509.

B. Background

USAF Hospital Hill/SGB requested the USAFOEHL conduct a comprehensive noise survey in the new depot armament repair building at Hill AFB UT. Construction of the new facility was completed in Feb 88, and operations were moved in during Mar 88. The bioenvironmental engineer was concerned that insufficient consideration had been given to noise control in the building's design. The Maintenance Directorate engineers requested SGB's help in addressing current and anticipated noise problems inside the facility.

Depot maintenance is performed on the following items in this facility: ejection seats, aircraft and hand-held guns, ammunition drums, bomb/missile racks, pylons, ejectors and launchers, short range attack missiles (SRAM), and air-launched cruise missles (ALCM). Maintenance activities include the following functions on a daily basis: painting, stripping, cleaning, sheet metal working (i.e., riveting, grinding, cutting, sanding and polishing), and the use of various air-powered tools. The building is constructed with sealed cement floors, cinder block walls, and corrugated sheet metal roofing, with no planned acoustic absorbing materials to prevent the buildup of sound energy reverberations.

C. Scope

The main thrust of the survey centered on the measurement of reverberation times for each room of concern in Bldg 509. Reverberation time measurements were made in Material Inventory Control, Sheet Metal Repair, the Main Bay, ALCM Repair, F-4 Seat Repair, F-16 Seat Repair, and Gun Repair. Figure 1 is a schematic floor plan of Bldg 509 and shows each of the areas surveyed. One major deviation from the drawing must be noted. The area indicated on the drawing as the ALCM Test area was not the ALCM Repair area we surveyed. ALCM repair operations were being conducted in the southwest corner of the Shipping and Receiving area indicated in Figure 1. Recordings were also made of the ambient noise under normal operating conditions in all areas of interest. These recordings were analyzed for frequency and level to determine the spectral energy of the noise present in each room. Preferred Speech Interference Levels (PSIL) were calculated from the spectral information in each area. PSIL levels are presented to show the effects of the noise on the quality of person-to-person voice communication. Specific recommendations for engineering noise controls in each room or area are provided.

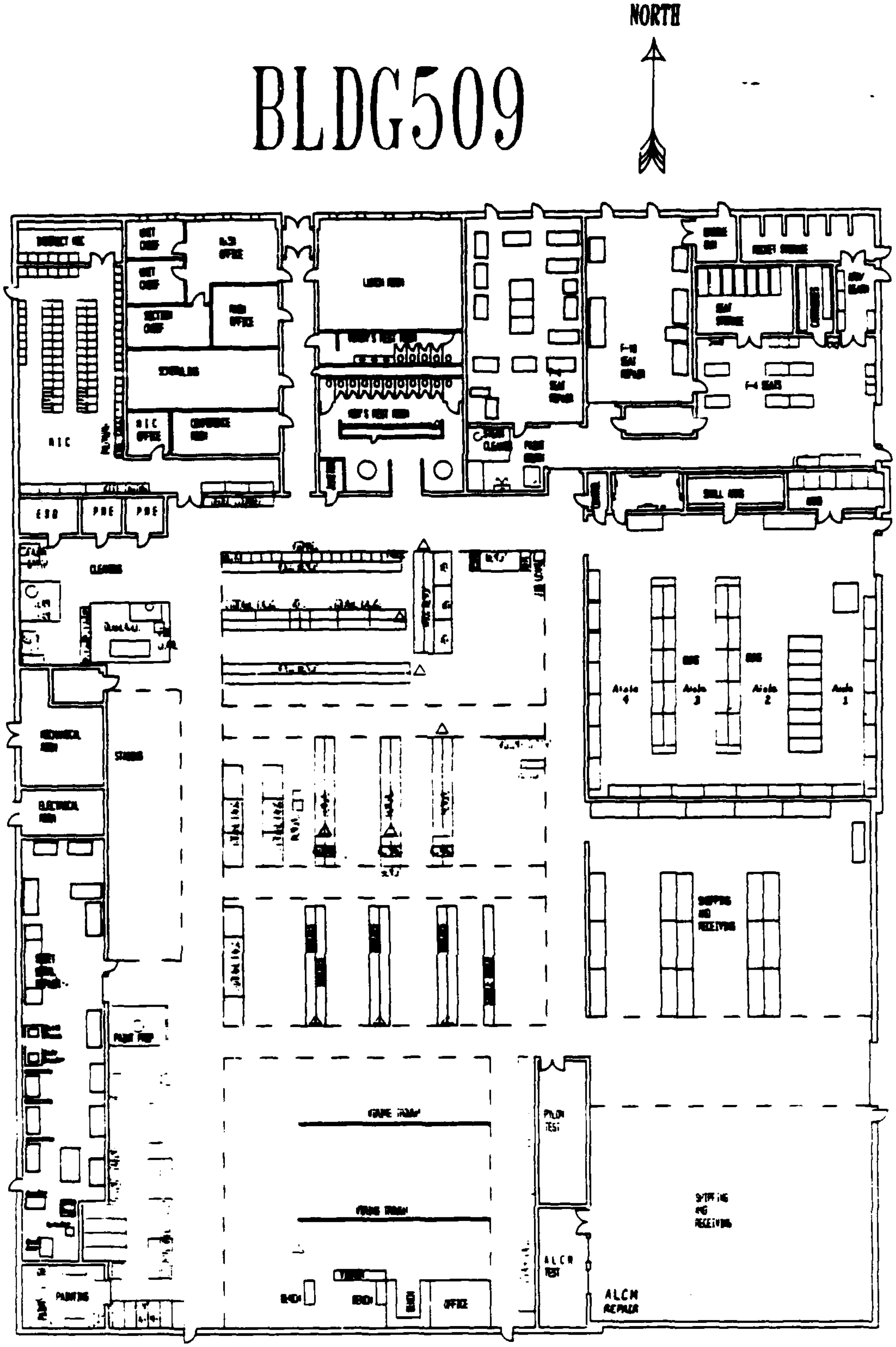


Figure 1: Depot Armament Repair Floor Plan

II. DISCUSSION

A. Method

Reverberation measurements were performed using the Bruel & Kjaer (B&K) sound source Type 4224 with the wideband source selected. The sound source was positioned facing one or more corners of the rooms surveyed depending on the room size and number of measurements required. Four microphones on tripods of different heights were located at selected positions in each room. Each microphone was fed to a separate channel or track of a B&K Type 7006 FM tape recorder. The noise source was controlled with a remote switch to turn it on and off as needed. The recordings began with the noise source turned on, and were allowed to continue after the source was abruptly turned off, thus capturing the decaying level of the noise signal with time. These recordings were subsequently analyzed at USAFOEHL using the B&K Type 2131 real time spectrum analyzer and a software program developed specifically for determining reverberation times in 1/3 octave bands with the B&K real time analyzer.

Background noise measurements were also obtained under normal operating conditions in each area of interest in Bldg 509. The same recording and analysis system was used.

The reverberation times were then used to calculate the individual room constants. The room constant is a measure of the total absorption of a room and was approximated in our calculations by:

$$R = Sa\ (ft^2)$$

where

a = average absorption coefficient

S = total surface area (ft^2)

R = room constant (ft^2 or sabins)

The average absorption coefficient was estimated from the measured reverberation times using the following formula which closely approximates the relation between reverberation time at room temperature to the room dimensions and the total absorption:

$$T_{60} = 0.049V/A\ \ (sec)$$

where

V = room volume (ft^3)

A = total room absorption (ft^2)

T_{60} = reverberation time (time for sound pressure level to decay 60 dB)

This approximation ignores the air absorption coefficient which depends on relative humidity and frequency. Except for extremely large rooms, air absorption is negligible below 1000 Hertz (Hz), and makes only a small contribution in extremely large rooms at frequencies above 1000 Hz. Therefore, we chose to ignore the air absorption term in the above equation.

B. Results

Our measured results for reverberation times in each room are presented in Appendix A, and the calculated room constants in Appendix B.

The spectral analysis results are presented in tabular and graphical form in Appendix C. Tables and Figures 1 through 6 in Appendix C are a series of measurements performed at various locations in the Main Bay and Shipping & Receiving with only the spray paint booth in the paint preparation area operating. These measurements were obtained during the evening when reverberation measurements were being made with no individuals, other than survey personnel, in the building. The spray paint booth was therefore the only noise source operating for these measurements. A comparison was then made with the spray paint booth operating during a quiet time versus normal daily operation. This showed the spray paint booth is the dominant noise source in the area when it is operating. Tables and Figures 19 and 20 represent areas measured in the main bay during normal operations with the spray paint booth turned on. The remaining tables and figures in Appendix C are measurements of normal activities as indicated.

The octave band results from the tables in Appendix C were used to calculate the Preferred Speech Interference Levels (PSIL) shown in Appendix D. As described in AFR 161-35, Hazardous Noise Exposure, PSIL in decibels (dB) is the arithmetic average of the levels of the four octave bands centered on the preferred frequencies 500, 1000, 2000, and 4000 Hz. Use of Figure 1 and Table 7 from AFR 161-35 will enable one to determine the effectiveness of person-to-person voice communication at various speaker to listener distances under the noise conditions measured. These noise exposure limits are used only to maintain effective job performance and are not for hearing conservation purposes.

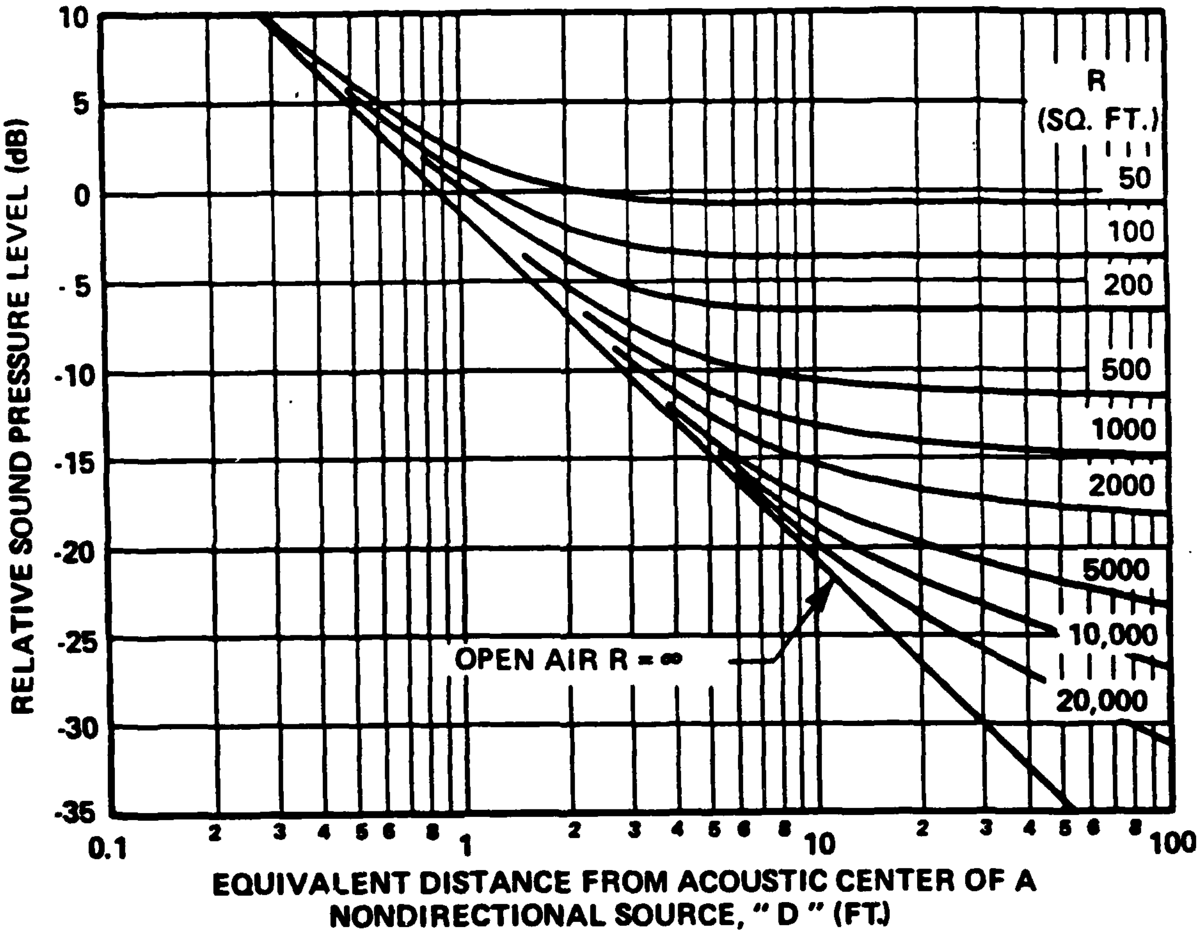
C. Observations

A review of the reverberation times in Appendix A shows some anomalies worth mentioning. There is good agreement for reverberation times in bands 26 thru 37 (400-5000 Hz), the mid frequency range, as indicated by the low standard deviations. The reverberation times shown in bands 20-25 and bands 38-43 represent the lower and upper frequency limitations of our sound source. This, in combination with inherent limitations of the reverberation software program, leads us to believe the reverberation times in these frequency bands may not be accurate representations of the actual reverbera- tion times in the low and high frequency regions. This measure of doubt concerning the low and high frequency reverberation times does not affect the noise control recommendations we are making since we have a high level of confidence in the mid-band frequencies.

The room constant results in Appendix B, show each room has some inherent absorption due to large desks, benches, and equipment placed in each room, even though no acoustic treatment had been applied. If the rooms were totally reverberant, we'd expect much lower room constants on the order of 20 to 50 sabins. The octave band room constants for Sheet Metal ranged from 1100 to 1500 sabins; 400 to 800 sabins for F-4 Seat Repair; 400 to 740 sabins for F-16 Seat Repair; 600 to 3100 sabins for Gun Repair; 5300 to 8400 sabins for ALCM Repair; 800 to 1000 sabins for Material Inventory Control; and 9500 to 18,000 sabins for the Main Bay area. ALCM Repair (Shipping & Receiving) and the Main Bay are the two rooms in Bldg 509 with the largest volumes. They also have the largest calculated room constants, thus the most absorption. This is due mainly to the size of each room, but also to the number of storage shelves and benches in the case of ALCM Repair (Shipping & Receiving). Even without acoustic treatment, sound energy is dissipated by air absorption. Air absorption increases as the distance sound must travel before being reflected by a wall increases. Larger rooms mean fewer reflections, and thus less likelihood of reverberant sound energy buildup. Material Inventory Control, although moderately reverberant, has no major noise sources. There are holes near the ceiling in the wall adjacent to the Main Bay steam cleaning area, which allows some of the noise from outside the room to get in.

All of these rooms, with the exception of the Main Bay area and ALCM Repair (Shipping & Receiving), should benefit from a generous application of additional absorptive treatment. An overall noise level reduction of 4 to 7 decibels in each room could be achieved for distances from the source beyond 10 feet by increasing the room constant to 5000 sabins. This represents an increase of 5 times the original absorption in Sheet Metal, approximately 10 times the original absorption in F-4 and F-16 Seat Repair, and 2.5 times the original absorption in Gun Repair. Little benefit is obtained within 10 feet since this generally places one in the near field of the sound source, i.e., the operator's position where direct transmission is the primary route of received energy. Figure 2 shows the approximate relationship between relative sound pressure level and distance to a sound source for various room constant values. The decibel benefit of increasing the absorption in rooms with room constant values higher than 5000 sabins must be weighed against the additional costs of the acoustic treatment materials.

The increased absorption can most effectively be obtained by suspending absorbing panels or space units in the ceiling areas of each room. If the surface areas of the ceilings are not large enough to allow installation of absorbing material sufficient to obtain the desired room constant, then consider adding similar absorbing panels to the wall areas. An aspect of spacing which is often overlooked when trying to place all additional absorbing materials in the ceiling is that the panels do not have to be suspended symmetrically, uniformly, or even horizontally. In fact, more effective absorption is obtained when the panels are staggered and alternately suspended vertically and horizontally. This type of treatment should improve the quality of person-to-person voice communication and personal comfort in each room even if there is no significant reduction in the worker's overall noise exposure levels.



Note: This figure has been adjusted to take into account large obstacles or large pieces of equipment distributed about the room. Therefore, the curves for large values of R do not agree with similar textbook curves that tend to ignore such obstacles.

Figure 2: Approximate relationship between "Relative Sound Pressure Level" (REL SPL) and distance to a sound source for various "Room Constant" values.

The F-4 and F-16 Seat Repair rooms are also adversely affected by the noise from the steam cleaning booth operation immediately outside their doors. The doors are left open for air circulation. Reducing the noise from the steam cleaning operation would greatly benefit the seat repair rooms as well. Presently the only barrier around the steam cleaning booth is a non-acoustic shower curtain which does nothing for attenuating noise. The noise level from the steam cleaning operation varies. The noisiest period, 96 dB(A), is immediately upon startup. Once the steam flow settles to its normal operation, the noise drops off to 79 dB(A). Figures 13 through 15 in Appendix C, and their corresponding tables, show the noise levels for this steam cleaning operation. The normal background level in this area without the steam cleaning operation on is 64 dB(A). The steam cleaning operation in the Main Bay area has the same startup noise problems and approximately similar noise levels for normal operation as seen in Figures and Tables 27-30 in Appendix C. The difference with the Main Bay steam cleaning operation is that its noise output is dissipated into a much larger volume room making its impact on adjacent areas much less.

The spray paint booth in the Main Bay paint preparation area is a dominant noise source throughout the Main Bay and Shipping & Receiving when it is turned on. There is little difference in the noise levels present during normal daily operation with the spray paint booth on versus the levels present with the spray paint booth on when we measured in the evening. For example, we measured 71 dB(A) in the Pylon Repair area when the spray paint booth was operated in the evening versus 73 dB(A) when operating during the normal daily routine. It was our observation that the other spray paint booth in the enclosed painting room would have to be operated with the doors to the room open for makeup air to flow across the face of the booth. If this is the case, this spray painting operation will also be a major noise contributor to the operations in the Main Bay area.

During our survey we observed that almost all of the outside doors were kept open. The building apparently is not equipped with air conditioning. The doors are left open to allow fresh air to circulate through the building. Floor fans are used in some locations to improve the cooling circulation. These fans obviously create more noise, but the real problem with leaving the doors open is the intrusion of aircraft flyover noise into the building. In many areas of the building, this exposure is the dominant noise source for workers during the day.

A review of the Preferred Speech Interference Levels (PSIL) in Appendix D indicates most of the rooms surveyed would require the use of a raised voice to achieve satisfactory person-to-person voice communications depending on the operations being conducted in each room at any given time. The Sheet Metal Repair room had the highest PSILs due to the riveting operations. In Sheet Metal Repair, the PSIL ranged from 62 to 63 dB under normal background conditions, to a high of 86 dB with riveting. The PSIL values in the Main Bay ranged from 61 to 67 dB. In Gun Repair the PSIL was about 60 dB, although operations in Gun Repair when we made measurements were reported to be unusually quiet. The F-4 Seat Repair PSIL was 63 dB, F-16 Seat Repair PSIL was 54 dB, and ALCM Repair PSIL was 53 dB.

III. CONCLUSIONS

Several rooms in the new Depot Armament Repair facility would benefit from engineering noise controls in the form of additional acoustic absorption. The rooms which would benefit most include: Sheet Metal Repair, F-4 and F-16 Seat Repair, and Gun Repair. Each of these operations includes activities which create hazardous noise.

No acoustic controls are required in Material Inventory Control since there are no noise sources in this room.

The Main Bay area has two major noise sources for which engineering noise controls should be considered. These sources are the spray paint booth and the steam cleaning operation. If these noise sources can be effectively controlled, further noise control treatment in the Main Bay may prove to be unnecessary. Most of the noise sources found in the Main Bay are hand-held pneumatic tools, which are going to present a noise problem to the operators and other persons in the near-field of these sources. Controlling this type of noise is difficult. Installation of acoustic absorption material in the ceiling area of the Main Bay may not be a cost effective noise control in terms of the decibel noise reduction that would be achieved if the purpose of such installation is only for health considerations. However, it may have the side benefit of increasing worker morale and therefore productivity. Increasing the room absorption would undoubtedly improve the audibility of announcements made over the public address system.

The ALCM Repair (Shipping & Receiving) area requires no noise controls. This area is one of the quietest work areas in the building. The major noise source here is from forklifts and other tow vehicles that enter the high bay. This room is also highly subject to aircraft flyover noise when the outside bay doors are open.

Except for Sheet Metal Repair, the calculated PSILs do not indicate unusual difficulties with person-to-person voice communications will always be present. Some difficulty might occur in other rooms if the activity level and individual noise sources increased above the levels we observed. It is obvious in Sheet Metal Repair that telephone use in this room will be very difficult at times, and satisfactory person-to-person voice communications will only be possible with very short speaker to listener distances. Under the present acoustic conditions, satisfactory voice communications in the other areas of Bldg 509 can deteriorate if the level of noisy activities goes up even slightly.

IV. RECOMMENDATIONS

A. Sheet Metal Repair

Acoustic absorbing material in the form of panels or baffles should be installed in the ceiling area of this room to obtain a room constant value of at least 5000 sabins. Although Figure 2 indicates a significantly better noise reduction could be achieved from one end of the room to the other if the acoustic absorption of the room was increased to 1000 sabins, we do not believe this would be practical. Since the room is long and narrow there is limited surface

area on the walls and ceiling of this room in which to install absorbing materials. You should try to get as much additional absorbing material over, 5000 sabins, in this room as possible. We believe a room constant value of 5000 sabins is a reasonable goal to achieve.

Consider isolating the noisier operations, i.e., riveting, grinding, and sanding, to one end of the room with the use of portable absorbing partitions, or screens, around each work station. This is the most effective way to reduce a worker's accumulated noise exposure. Noise screens block and dissipate reflected noise along the transmission path. When strategically located, they can effectively shield other workers from the direct energy of a noisy source. Acoustic screens can also be effective to partially enclose the desks in this room. With the high ceiling in this room, you should look for a desk screen with a height of about 8 to 10 feet rather than the 5 to 6 foot high screens currently in use.

The Sheet Metal Repair area is also a room which has several openings in the walls near the ceiling through which pipes and electrical conduits pass to adjacent rooms. Barring any unknown safety consideration, these holes should be sealed up tightly to prevent noise in Sheet Metal Repair from escaping into adjacent rooms. This can be done by extending the cinder block construction all the way up to the ceiling and mortaring in or caulking around pipes and wires.

B. F-4 and F-16 Seat Repair

Installation of additional acoustic absorbing materials will benefit each of these rooms. Again a reasonable goal for additional acoustic absorption would be to achieve a room constant of 5000 sabins each. This is a ten-fold increase in the room absorption for each room and therefore should have very noticeable effects. Since these rooms are somewhat smaller than the Sheet Metal Repair room, the use of acoustic screens to isolate noisy operations may not be as effective or practical. However, you should consider the use of acoustic screens to isolate particularly noisy operations such as riveting if such work is performed in the Seat Repair area.

C. Gun Repair

The Gun Repair room had the longest average reverberation time, although because of its volume it appears to have a room constant value of about 2000 sabins. The acoustics would improve if the room constant was increased to 5000 sabins. We did not observe any particularly noisy activity in this room during our survey, so we cannot recommend isolating specific operations. If such activities exist in Gun Repair, then consider the use of acoustic screens, as in Sheet Metal Repair, to isolate these operations from quieter activities.

D. ALCM Repair (Shipping & Receiving)

No specific acoustic noise controls are recommended in this area, since it is one of the quietest work stations. If ALCM Repair operations are to continue to occupy the southwest corner of the Shipping & Receiving room, and noise from the shipping and receiving operation becomes a big concern, then you may wish to isolate the ALCM Repair area with the use of an acoustic curtain or screens. If the aircraft flyover noise becomes objectionable, the outside doors to the high bay area should be closed.

E. Material Inventory Control

No noise control treatment is required in this area. However, holes through the walls for pipes and electrical lines should be sealed up to prevent outside noise from intruding into this room.

F. Main Bay

Acoustic treatment of the ceiling of this room should be a last consideration. Isolating the spray paint booth and the steam cleaning operation should be your first priorities. Acoustic enclosures for the steam cleaning areas are discussed in the next section. The spray paint booth area in the Main Bay should be completely isolated from the rest of the room to effectively reduce the intrusion of its noise output into other areas of the room. This may be achieved in one of two ways. You may be able to purchase an acoustic isolation booth for this operation, or you may wish to build a block wall all around the spray paint booth, sealing it all the way up to the ceiling. Supply air from outside the enclosure for the spray paint booth should be obtained through the ceiling rather than from the Main Bay area, and may have to be pushed (i.e., using a supply air fan) as well as pulled through the spray paint booth exhaust. Electrical lines and air supply lines would have to be rewired to accessible areas.

As noted in the observations section, there is a second spray paint booth in the same general area which is already enclosed in a separate room. However, it looked as if the door to this booth area would have to remain open during operation to supply makeup air for the spray paint booth. If this is the case, we recommend the solution for reducing the noise intrusion into the Main Bay from both these sources is to completely isolate the entire spray painting area of the room. A wall from floor to ceiling should be constructed from the high door for Sheet Metal Repair, out to the aisle, and all the way back to the south wall of Bldg 509 (see our drawing, Figure 3). A high door entry/exit would be required along the wall next to Pylon Repair to move parts for painting in and out. Makeup air for both spray paint booths could be supplied from the roof.

We were informed that acoustic isolation booths for the office areas in the Main Bay were either on order or being considered for purchase. We recommend such booths be considered only as a last resort. If the noise sources mentioned above for the Main Bay are effectively isolated, these office enclosure booths may not be required. We see little need for them even under current conditions. They certainly are not required to control hazardous noise exposures to supervisors, as the measured noise levels in this area of the Main Bay are not hazardous. We did not observe supervisory personnel spending a great deal of time during the day stationed at their desks. Therefore, we do not believe the cost of isolation booths is justified by the acoustic advantage to be gained. Adequate control of noise may be achieved through isolation of both the spray paint booth and the steam cleaning operation. If further treatment is required for improved person-to-person voice communication and telephone conversations in this office area, we would recommend applying some acoustic absorbing panels on the east walls of the Main Bay and possibly using taller isolation screens around each desk. Another possibly cheaper alternative to isolation booths would be an isolation curtain between the office and work sections of the Main Bay. At any rate we do not recommend any specific engineering noise control work be accomplished for the office area until the effects of other noise abatement work in the Main Bay area are observed.

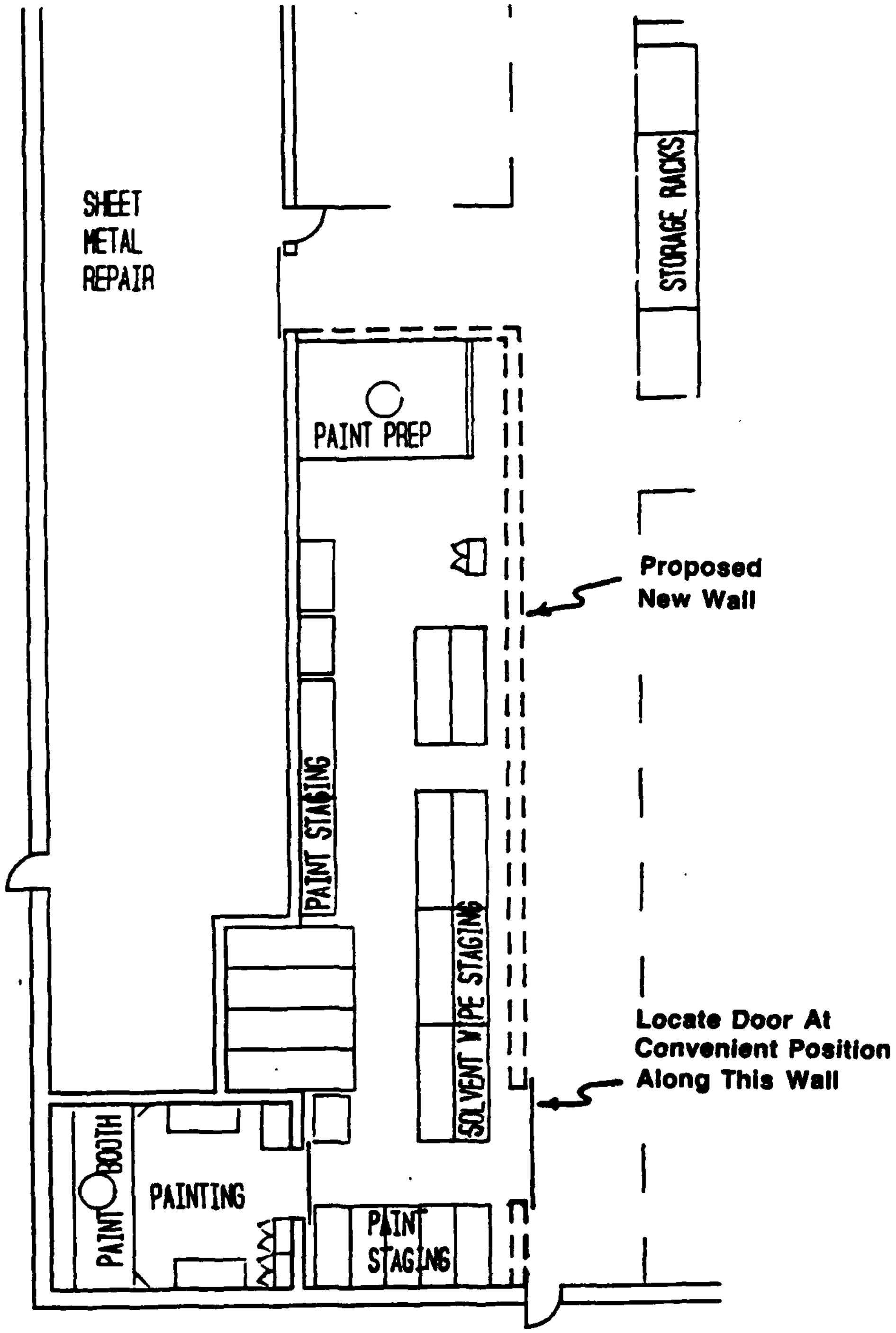


Figure 3: Schematic floor plan of proposed wall to be constructed enclosing the spray painting area of the Main Bay.

Other noise sources in the Main Bay are primarily hand held pneumatic tools. The Maintenance Directorate should continue to pursue the purchase of quieter tools and equipment. This is the most cost effective means to reduce personnel noise doses. With most hand held pneumatic tools, two mechanisms are mainly responsible for the noise generation. These are the air exhaust and workpiece radiation. Report number 4655 by Bolt Beranek and Newman,Inc., (BBN) describes a simple method for determining which of the two noise generating mechanisms is the most significant in any particular case. The BBN report also provides adequate discussion of various methods of controlling the noise from hand held pneumatic tools. Rather than summarize the BBN report, we are including paragraph 4.1 on pneumatic tools from the report in Appendix F to this report. The recommendations from the BBN report should be applicable for noise control of pneumatic tools throughout Bldg 509, not just the Main Bay area.

The mechanical and electrical rooms located along the west wall behind the staging area have openings into the Main Bay area. As we did not have access to these rooms during our survey, we could not tell if significant noise levels were coming through the openings. If this appears to be the case, and there are no safety considerations in sealing up the openings, then we certainly recommend these openings be closed.

G. Steam Cleaning Operations

The two steam cleaning operations in Bldg 509 require complete enclosures to effectively reduce their noise output. A properly installed two tiered noise control curtain system would contain the majority of the noise created by the steam cleaning operations. The lower curtain portion should be of a mass-loaded, transparent vinyl material cut into overlapping strips. This material is pliable and soft to touch, but is acoustically hard. It readily reflects sound from its surface. The transparent strips provide 100% visibility of the operation and offer quick access from any location along the enclosure. The upper or valance portion of the two tiered curtain is constructed of a composite barrier/absorber material. Absorption is required in the curtain system to prevent scattering reflections and to dissipate the sound energy. The valance portion should be an enclosure extending all the way up to the ceiling. It is possible to realize a 12 dB(A) reduction in noise level outside the enclosure using such a noise control curtain system.

H. General Recommendations

We believe it advisable to tackle one room at a time in your engineering noise control efforts for the new Depot Armament Repair Building. If our recommendations for acoustic noise control prove effective in one room, it is reasonable to assume they will be just as effective in the other rooms where similar controls were recommended. As a means of demonstrating the effectiveness of controls, we recommend you begin now to collect noise dosimetry data on both people and areas you expect to target with noise controls. Once noise controls are in place, you should remonitor in the same areas to show the before and after exposure levels.

Since USAFOEHL/ECH is not a full service noise control company (i.e. manufacturing and installing acoustic materials) we are reluctant to recommend any specific manufacturer's products and services to solve your problem. We have no firsthand knowledge of how well any

manufacturer's acoustic products work in specific applications. Therefore, we leave it up to you to select the company who will supply your acoustic treatment. Keep in mind proper installation is often just as important as buying the right product. To assist you in selection, we are providing information on manufacturers who supply the types of noise abatement products we've recommended in this report in Appendix E. Manufacturers' product literature was forwarded earlier in our interim report.

When evaluating one product against another, you should look at the Noise Reduction Coefficient (NRC) as the single number of merit for comparing absorption materials. NRC is the arithmetic average of the sound absorption coefficients measured at 250, 500, 1000, and 2000 Hz. It is customary to round off the NRC value to the nearest 0.05 and to treat competitive products as acoustically comparable if their NRC values agree to within 0.05. An NRC value of 0.65 does not mean 65% of the noise will be reduced with the use of that material. All other factors of room acoustics will determine the amount of noise reduction when a particular sound absorption material is added to a room. You should select materials with high absorption coefficients in the frequency region giving you the most problem, i.e., the highest octave band noise levels measured during normal operations. If the noise being targeted for control has frequency components outside the 250-2000 Hz range, then the NRC rating will be of little use in your selection of acoustic abatement materials. The 1/3 and octave band measured noise level data in Appendix C should assist you in this selection process.

References

1. AFR 161-35, Hazardous Noise Exposure (9 April 1982)

2. Bell, Lewis H., Industrial Noise Control. New York: Marcell Dekker, Inc., (1982)

3. Broch, Jens T., Acoustic Noise Measurements. Published by: Bruel & Kjaer Instruments, Inc. (1971)

4. Miller, Laymon N., Noise Control for Buildings and Manufacturing Plants. Published by: Bolt Beranek and Newman, Inc. (1982)

5. Potter, Richard C., C. Jokel, M. Thorpe, and P. Jensen, Industrial Noise Control Consultation to Oklahoma City Air Logistics Center (AFLC), Tinker Air Force Base. Report No. 4655 by: Bolt, Beranek and Newman, Inc. (1981)

APPENDIX A

REVERBERATION TIMES

(This page left blank)

REVERBERATION TIMES

SHEET METAL REPAIR

Freq (Hz)	Band Number	Mean Reverberation Time (Sec)	Standard Deviation From Mean	Total Number Of Runs Averaged
100	20	2.04	.38	40
125	21	2.04	.32	40
160	22	2.04	.23	40
200	23	1.77	.14	40
250	24	1.53	.15	40
315	25	1.58	.23	40
400	26	1.59	.12	40
500	27	1.68	.09	40
630	28	1.71	.11	40
800	29	1.86	.07	40
1000	30	1.95	.07	40
1250	31	1.98	.07	40
1600	32	1.97	.07	40
2000	33	1.90	.05	40
2500	34	1.78	.05	40
3150	35	1.72	.07	40
4000	36	1.49	.05	40
5000	37	1.35	.07	40
6300	38	1.35	.17	40
8000	39	1.53	.37	40
10000	40	3.24	2.25	29
12500	41	15.98	15.03	11
16000	42	5.74	5.55	4
20000	43	***	***	0

*** : Insufficient Data To Calculate Reverberation Time

REVERBERATION TIMES

F-4 SEAT REPAIR

Freq (Hz)	Band Number	Mean Reverberation Time (Sec)	Standard Deviation From Mean	Total Number Of Runs Averaged
100	20	6.60	7.72	10
125	21	3.84	3.45	21
160	22	3.01	.75	24
200	23	2.99	.93	23
250	24	2.53	1.04	24
315	25	2.32	.60	24
400	26	2.34	.31	24
500	27	2.15	.21	24
630	28	2.37	.21	24
800	29	2.53	.22	24
1000	30	2.49	.20	24
1250	31	2.60	.23	24
1600	32	2.56	.16	24
2000	33	2.33	.09	24
2500	34	2.37	.57	23
3150	35	2.33	.45	24
4000	36	2.00	.60	24
5000	37	1.89	.73	24
6300	38	2.42	1.64	24
8000	39	3.62	4.75	20
10000	40	5.21	4.41	8
12500	41	***	***	0
16000	42	***	***	0
20000	43	***	***	0

***** : Insufficient Data To Calculate Reverberation Time**

REVERBERATION TIMES

F-16 SEAT REPAIR

Freq (Hz)	Band Number	Mean Reverberation Time (Sec)	Standard Deviation From Mean	Total Number Of Runs Averaged
100	20	3.77	1.47	19
125	21	3.79	1.15	20
160	22	3.35	.68	20
200	23	2.90	.52	20
250	24	2.27	.34	20
315	25	2.34	.35	20
400	26	2.55	.48	20
500	27	2.76	.20	20
630	28	2.81	.18	20
800	29	3.03	.33	20
1000	30	3.35	.45	20
1250	31	3.18	.20	20
1600	32	3.04	.14	20
2000	33	2.82	.10	20
2500	34	2.55	.09	20
3150	35	2.37	.14	20
4000	36	1.99	.12	20
5000	37	1.74	.06	20
6300	38	1.99	.37	20
8000	39	2.88	1.35	18
10000	40	11.93	12.41	8
12500	41	***	***	1
16000	42	***	***	0
20000	43	***	***	0

*** : Insufficient Data To Calculate Reverberation Time

REVERBERATION TIMES

GUN REPAIR

Freq (Hz)	Band Number	Mean Reverberation Time (Sec)	Standard Deviation From Mean	Total Number Of Runs Averaged
100	20	16.80	19.48	14
125	21	7.41	6.99	19
160	22	9.40	11.53	28
200	23	5.19	5.01	22
250	24	4.79	7.96	32
315	25	3.04	2.08	41
400	26	2.46	.80	44
500	27	2.36	.61	43
630	28	2.28	.43	44
800	29	2.60	.69	44
1000	30	2.67	.48	44
1250	31	2.69	.38	44
1600	32	2.45	.32	44
2000	33	2.32	.26	44
2500	34	2.17	.25	44
3150	35	2.06	.23	44
4000	36	1.74	.19	44
5000	37	1.84	.99	43
6300	38	2.20	1.95	38
8000	39	5.23	5.59	11
10000	40	6.91	6.38	13
12500	41	6.44	6.32	3
16000	42	12.14	12.08	3
20000	43	***	***	1

*** : Insufficient Data To Calculate Reverberation Time

REVERBERATION TIMES

ALCM REPAIR

Freq (Hz)	Band Number	Mean Reverberation Time (Sec)	Standard Deviation From Mean	Total Number Of Runs Averaged
100	20	2.88	.67	21
125	21	2.91	.51	21
160	22	2.76	.32	21
200	23	2.60	.64	20
250	24	2.32	.22	21
315	25	2.42	.30	21
400	26	2.40	.11	21
500	27	2.53	.09	21
630	28	2.64	.13	21
800	29	2.69	.10	21
1000	30	2.79	.10	21
1250	31	2.84	.12	21
1600	32	2.62	.59	20
2000	33	2.52	.07	21
2500	34	2.31	.06	21
3150	35	2.09	.08	21
4000	36	1.78	.06	21
5000	37	1.62	.07	21
6300	38	1.53	.20	21
8000	39	1.68	.72	18
10000	40	5.50	5.08	4
12500	41	***	***	0
16000	42	***	***	0
20000	43	***	***	0

*** : Insufficient Data To Calculate Reverberation Time

REVERBERATION TIMES

MATERIAL INVENTORY CONTROL

Freq (Hz)	Band Number	Mean Reverberation Time (Sec)	Standard Deviation From Mean	Total Number Of Runs Averaged
100	20	1.95	.27	40
125	21	2.07	.36	40
160	22	2.11	.19	40
200	23	1.81	.27	40
250	24	1.43	.15	40
315	25	1.46	.25	40
400	26	1.43	.11	40
500	27	1.56	.09	40
630	28	1.70	.10	40
800	29	1.87	.15	40
1000	30	1.91	.11	40
1250	31	1.96	.10	40
1600	32	2.06	.13	40
2000	33	1.98	.10	40
2500	34	1.81	.10	40
3150	35	1.77	.09	40
4000	36	1.55	.06	40
5000	37	1.35	.07	40
6300	38	1.3	.13	40
8000	39	1.35	.75	29
10000	40	2.56	1.93	19
12500	41	19.98	19.12	10
16000	42	7.73	7.67	2
20000	43	***	***	0

*** : Insufficient Data To Calculate Reverberation Time

REVERBERATION TIMES

MAIN BAY

Freq (Hz)	Band Number	Mean Reverberation Time (Sec)	Standard Deviation From Mean	Total Number Of Runs Averaged
100	20	3.21	1.75	143
125	21	3.29	3.15	150
160	22	2.83	.74	150
200	23	2.52	.43	150
250	24	2.05	.36	150
315	25	1.97	.34	150
400	26	2.00	.29	150
500	27	2.04	.17	150
630	28	2.04	.19	150
800	29	2.31	.19	150
1000	30	2.38	.19	150
1250	31	2.34	.19	150
1600	32	2.29	.17	150
2000	33	2.14	.14	150
2500	34	2.01	.12	150
3150	35	1.88	.13	150
4000	36	1.60	.12	150
5000	37	1.46	.13	150
6300	38	1.58	.47	147
8000	39	2.33	1.80	86
10000	40	5.39	5.25	19
12500	41	5.84	5.82	2
16000	42	***	***	0
20000	43	***	***	0

*** : Insufficient Data To Calculate Reverberation Time

(This page left blank)

APPENDIX B

ROOM CONSTANTS

(This page left blank)

ROOM CONSTANTS

SHEET METAL REPAIR

Room Volume: **46,492 cubic feet**

Freq (Hz)	Band Number	1/3 Octave Band Room Constant (square feet)	Octave Band Room Constant (square feet)
	20	1094	
125	21	1117	1108
	22	1115	
	23	1289	
250	24	1486	1405
	25	1441	
	26	1430	
500	27	1354	1373
	28	1336	
	29	1227	
1000	30	1170	1182
	31	1150	
	32	1156	
2000	33	1202	1212
	34	1297	
	35	1322	
4000	36	1534	1515
	37	1688	
	38	1690	
8000	39	1486	1293
	40	703	

ROOM CONSTANTS

F-16 SEAT REPAIR

<u>Room Volume</u>: 30,240 cubic feet

Freq (Hz)	Band Number	1/3 Octave Band Room Constant (square feet)	Octave Band Room Constant (square feet)
	20	393	
125	21	391	409
	22	442	
	23	510	
250	24	654	599
	25	632	
	26	582	
500	27	538	549
	28	528	
	29	489	
1000	30	442	466
	31	467	
	32	488	
2000	33	525	531
	34	581	
	35	627	
4000	36	746	742
	37	853	
	38	746	
8000	39	515	462
	40	124	

ROOM CONSTANTS

F-4 SEAT REPAIR

Room Volume: **33,657 cubic feet**

Freq (Hz)	Band Number	1/3 Octave Band Room Constant (square feet)	Octave Band Room Constant (square feet)
	20	252	
125	21	430	410
	22	548	
	23	553	
250	24	651	639
	25	712	
	26	706	
500	27	766	723
	28	696	
	29	651	
1000	30	662	649
	31	634	
	32	644	
2000	33	707	682
	34	695	
	35	708	
4000	36	823	802
	37	874	
	38	682	
8000	39	456	485
	40	317	

ROOM CONSTANTS

GUN REPAIR

Room Volume: **121,105 cubic feet**

Freq (Hz)	Band Number	1/3 Octave Band Room Constant (square feet)	Octave Band Room Constant (square feet)
	20	353	
125	21	801	595
	22	631	
	23	1143	
250	24	1238	1443
	25	1950	
	26	2414	
500	27	2513	2509
	28	2599	
	29	2285	
1000	30	2220	2237
	31	2205	
	32	2424	
2000	33	2560	2572
	34	2732	
	35	2742	
4000	36	3420	3130
	37	3227	
	38	2829	
8000	39	1134	1607
	40	858	

ROOM CONSTANTS

ALCM REPAIR

Room Volume: **310,252 cubic feet**

Freq (Hz)	Band Number	1/3 Octave Band Room Constant (square feet)	Octave Band Room Constant (square feet)
	20	5286	
125	21	5233	5342
	22	5508	
	23	5845	
250	24	6542	6222
	25	6279	
	26	6324	
500	27	6018	6033
	28	5756	
	29	5662	
1000	30	5449	5487
	31	5349	
	32	5794	
2000	33	6033	6141
	34	6595	
	35	7267	
4000	36	8555	8406
	37	9396	
	38	9943	
8000	39	9038	7248
	40	2764	

ROOM CONSTANTS

MATERIAL INVENTORY CONTROL

Room Volume: **33,783 cubic feet**

Freq (Hz)	Band Number	1/3 Octave Band Room Constant (square feet)	Octave Band Room Constant (square feet)
	20	849	
125	21	801	811
	22	785	
	23	917	
250	24	1155	1069
	25	1134	
	26	1156	
500	27	1063	1065
	28	977	
	29	884	
1000	30	869	866
	31	845	
	32	805	
2000	33	834	852
	34	916	
	35	937	
4000	36	1070	1077
	37	1224	
	38	1274	
8000	39	1223	1048
	40	647	

ROOM CONSTANTS

MAIN BAY

Room Volume: 605,480 cubic feet

Freq (Hz)	Band Number	1/3 Octave Band Room Constant (square feet)	Octave Band Room Constant (square feet)
	20	9251	
125	21	9029	9585
	22	10476	
	23	11787	
250	24	14480	13778
	25	15068	
	26	14827	
500	27	14579	14643
	28	14522	
	29	12871	
1000	30	12471	12668
	31	12663	
	32	12973	
2000	33	13870	13875
	34	14783	
	35	15798	
4000	36	18589	18255
	37	20377	
	38	18801	
8000	39	12733	12346
	40	5503	

(This page left blank)

APPENDIX C

SPECTRAL RESULTS

Table 1: Hill AFB Depot Armament Repair Building.
Measurement Location: Face of Spray Paint Booth.
Measurement Conditions: Spray Paint Booth Operating.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	60.1	0.0	0.0			
4	66.0	0.0	0.0	71.6	0.0	0.0
5	69.9	0.0	0.0			
6.3	71.7	0.0	0.0			
8	75.8	0.0	0.0	80.5	8.7	63.5
10	77.7	7.3	63.5			
12.5	74.0	10.6	62.8			
16	73.9	17.2	65.4	78.9	25.1	70.9
20	74.6	24.1	68.4			
25	78.4	33.7	74.0			
31.5	74.3	34.9	71.3	82.9	45.9	80.0
40	79.9	45.3	77.9			
50	79.8	49.6	78.5			
63	77.8	51.6	77.0	88.0	64.6	87.4
80	86.8	64.2	86.3			
100	89.5	70.4	89.2			
125	82.1	65.9	81.9	90.8	73.3	90.5
160	81.6	68.2	81.5			
200	83.7	72.8	83.7			
250	81.6	73.0	81.6	86.4	77.2	86.4
315	77.9	71.3	77.9			
400	77.3	72.5	77.3			
500	77.4	74.2	77.4	82.0	78.8	82.0
630	77.0	75.0	77.0			
800	76.3	75.5	76.3			
1000	75.0	75.0	75.0	79.8	79.6	79.8
1250	73.4	74.0	73.4			
1600	71.8	72.8	71.7			
2000	70.2	71.4	70.0	75.2	76.3	75.0
2500	68.8	70.1	68.5			
3150	68.0	69.2	67.5			
4000	66.3	67.3	65.5	71.4	72.4	70.6
5000	65.2	65.7	63.9			
6300	64.1	64.0	62.1			
8000	62.9	61.8	59.9	67.6	66.7	64.8
10000	60.9	58.4	56.5			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 94.7 dB　　OASLA = 84.9 dB(A)

OASLC = 94.0 dB(C)　　C-A VALUE = +9.1

Figure 1: Hill AFB Depot Armament Repair Building.
Measurement Location: Spray Paint Booth Face.
Measurement Conditions: Spray Paint Booth Operating.

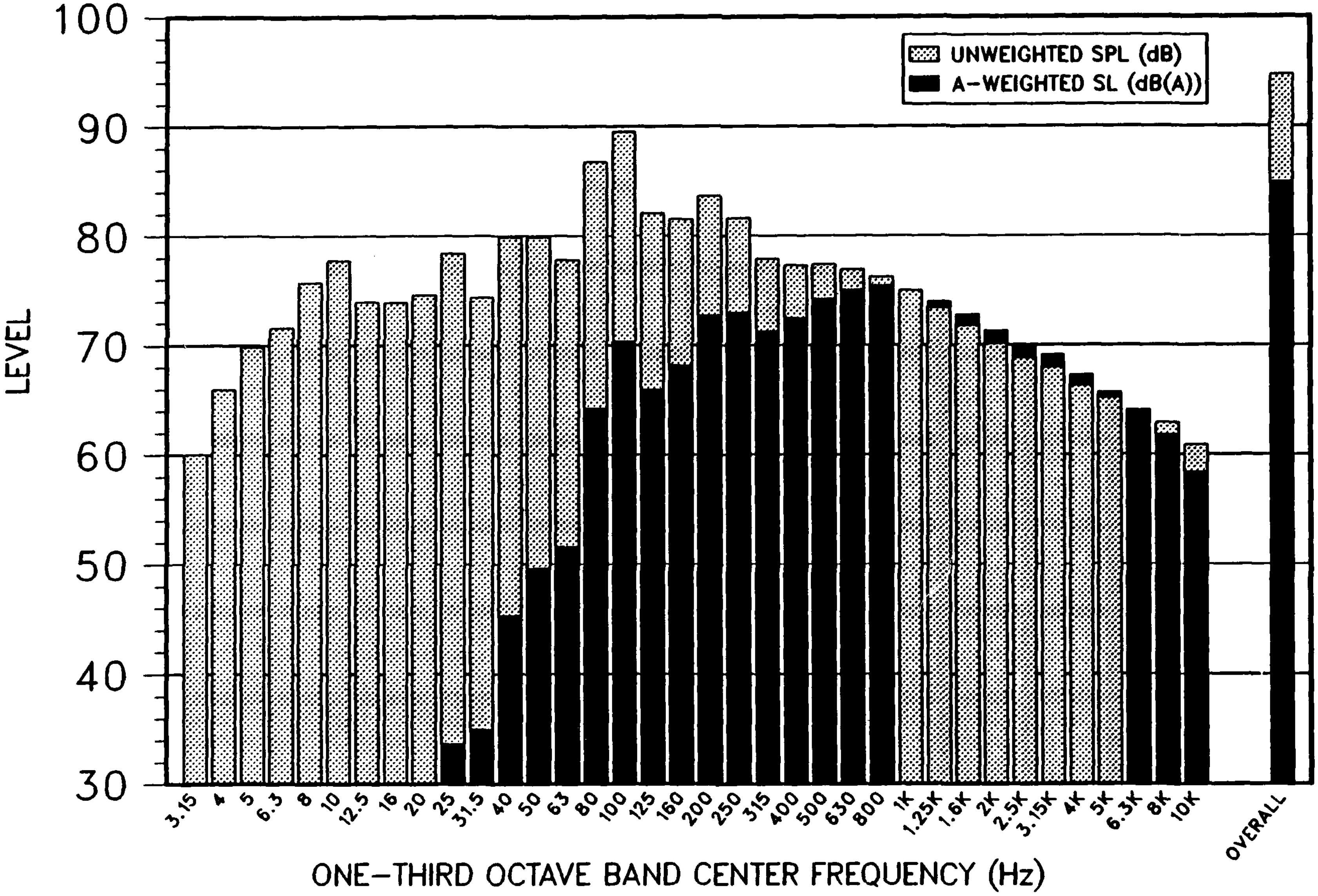


Table 2: Hill AFB Depot Armament Repair Building.
Measurement Location: Paint Preparation Office Area.
Measurement Conditions: Spray Paint Booth Operating.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	53.4	0.0	0.0			
4	55.8	0.0	0.0	63.7	0.0	0.0
5	62.3	0.0	0.0			
6.3	68.3	0.0	0.0			
8	67.7	0.0	0.0	72.3	4.8	52.0
10	66.3	0.0	52.0			
12.5	69.1	5.7	57.9			
16	68.8	12.0	60.3	73.2	18.2	64.6
20	67.1	16.6	60.9			
25	69.8	25.1	65.4			
31.5	74.3	34.9	71.3	76.2	37.1	73.0
40	67.0	32.4	65.0			
50	65.3	35.1	64.0			
63	60.7	34.5	59.9	69.8	45.3	69.0
80	67.0	44.5	66.5			
100	65.9	46.8	65.6			
125	72.8	56.7	72.6	77.0	62.4	76.8
160	74.3	60.9	74.2			
200	74.2	63.3	74.2			
250	66.9	58.3	66.9	75.3	65.4	75.3
315	64.9	58.3	64.9			
400	63.3	58.5	63.3			
500	63.6	60.4	63.6	68.3	65.2	68.3
630	63.7	61.8	63.7			
800	64.1	63.3	64.1			
1000	62.6	62.6	62.6	67.4	67.2	67.4
1250	60.6	61.2	60.6			
1600	60.0	61.0	59.9			
2000	58.4	59.6	58.2	63.4	64.6	63.2
2500	57.0	58.2	56.7			
3150	55.2	56.5	54.7			
4000	53.3	54.3	52.5	58.4	59.4	57.7
5000	51.6	52.1	50.3			
6300	49.4	49.3	47.4			
8000	46.8	45.7	43.8	52.0	51.4	49.5
10000	43.6	41.1	39.3			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 82.8 dB　　OASLA = 72.5 dB(A)

OASLC = 81.1 dB(C)　　C-A VALUE = +8.6

Figure 2: Hill AFB Depot Armament Repair Building.
Measurement Location: Paint Preparation Office Area.
Measurement Conditions: Spray Paint Booth Operating.

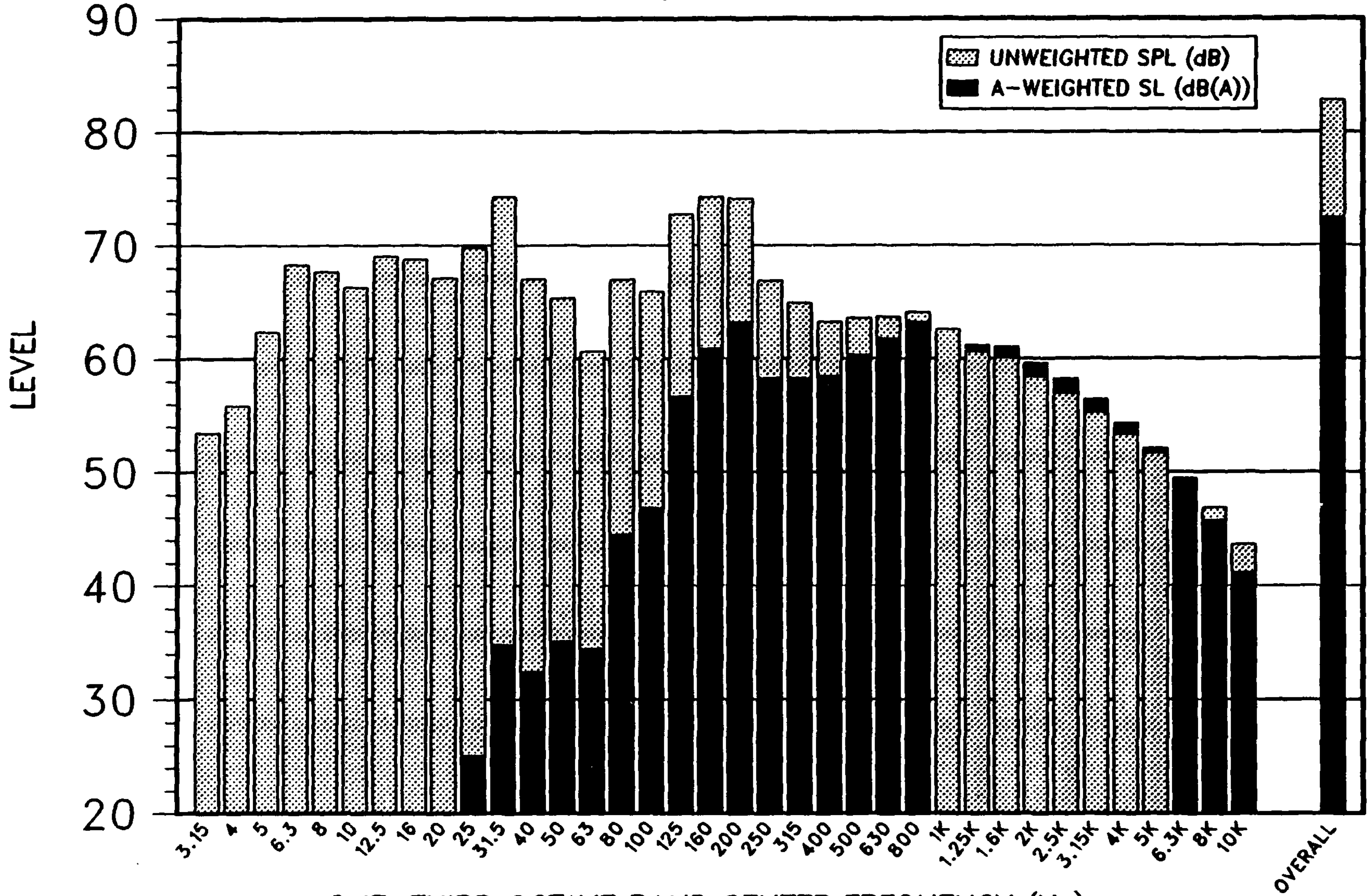


Table 3: Hill AFB Depot Armament Repair Building.
Measurement Location: Center of Pylon Repair Area.
Measurement Conditions: Spray Paint Booth Operating.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	54.4	0.0	0.0			
4	52.8	0.0	0.0	58.2	0.0	0.0
5	52.8	0.0	0.0			
6.3	51.2	0.0	0.0			
8	53.8	0.0	0.0	63.1	4.8	47.9
10	62.2	0.0	47.9			
12.5	58.1	0.0	46.8			
16	63.0	6.3	54.5	66.1	12.6	58.3
20	61.6	11.1	55.4			
25	65.2	20.5	60.8			
31.5	68.1	28.7	65.1	71.9	34.6	69.1
40	67.7	33.1	65.7			
50	67.3	37.1	66.0			
63	65.2	39.0	64.5	71.5	46.4	70.6
80	67.3	44.8	66.8			
100	70.3	51.2	70.1			
125	68.7	52.6	68.5	75.1	59.8	74.9
160	71.4	58.0	71.3			
200	71.5	60.6	71.5			
250	68.9	60.3	68.9	73.9	64.4	73.9
315	64.1	57.5	64.1			
400	63.2	58.4	63.2			
500	63.0	59.8	63.0	67.7	64.5	67.7
630	62.6	60.7	62.6			
800	62.8	62.0	62.8			
1000	61.8	61.8	61.8	66.5	66.3	66.5
1250	60.0	60.6	60.0			
1600	58.6	59.6	58.5			
2000	56.0	57.2	55.8	61.6	62.7	61.4
2500	54.9	56.2	54.6			
3150	52.8	54.0	52.3			
4000	50.6	51.6	49.8	55.8	56.8	55.1
5000	48.6	49.1	47.3			
6300	45.8	45.7	43.8			
8000	43.1	42.0	40.1	48.4	47.7	45.8
10000	40.0	37.6	35.6			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 80.2 dB   OASLA = 71.2 dB(A)

OASLC = 79.4 dB(C)   C-A VALUE = +8.2

Figure 3: Hill AFB Depot Armament Repair Building.
Measurement Location: Center of Pylon Repair Area.
Measurement Conditions: Spray Paint Booth Operating.

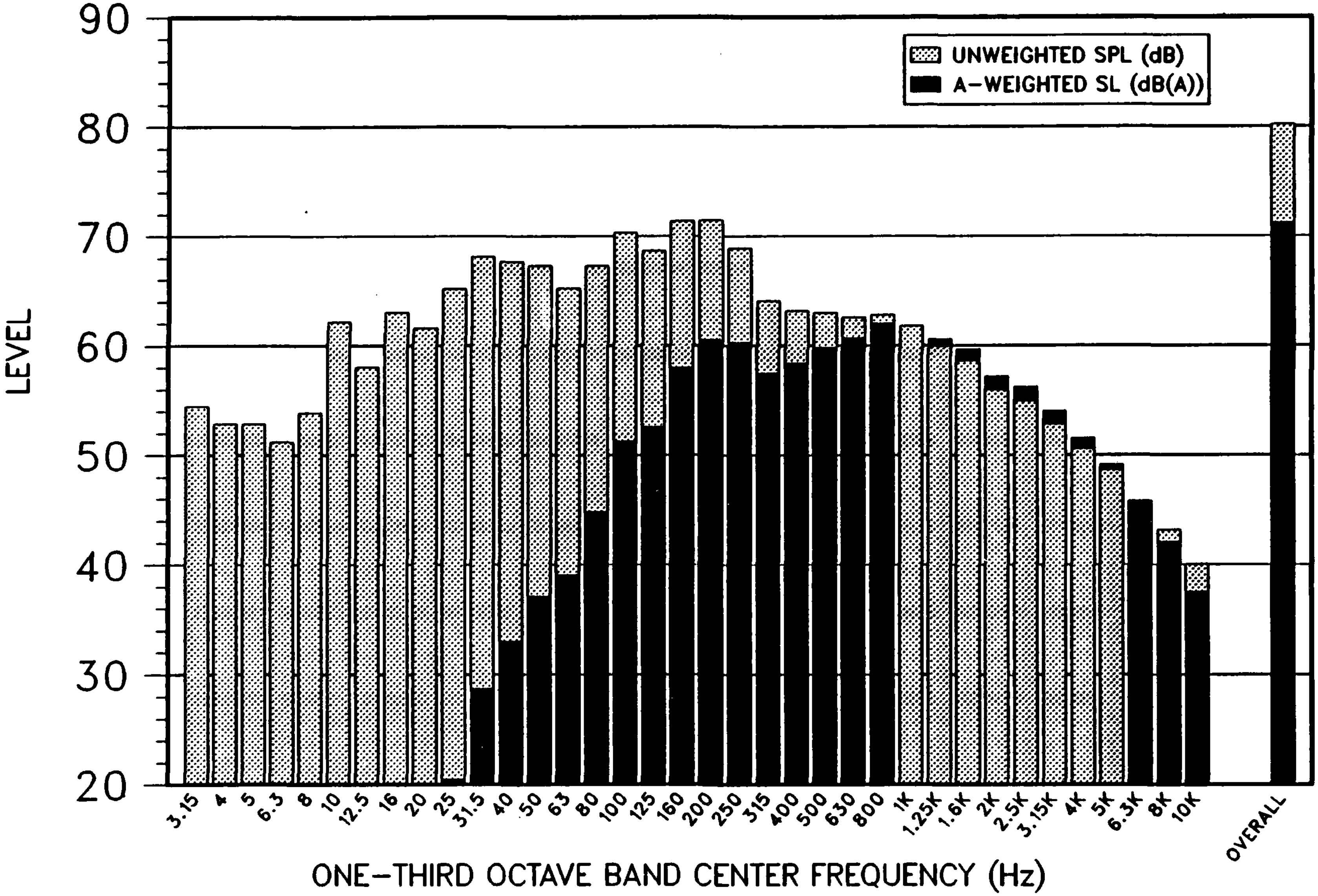


Table 4: Hill AFB Depot Armament Repair Building.
Measurement Location: Center of Bomb Rack Repair Area.
Measurement Conditions: Spray Paint Booth Operating.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	50.3	0.0	0.0			
4	51.2	0.0	0.0	57.2	0.0	0.0
5	54.5	0.0	0.0			
6.3	57.4	0.0	0.0			
8	56.5	0.0	0.0	62.7	4.8	45.2
10	59.5	0.0	45.2			
12.5	61.2	0.0	49.9			
16	63.4	6.7	54.9	66.2	10.7	57.6
20	58.2	7.7	52.0			
25	63.9	19.2	59.5			
31.5	66.7	27.4	63.8	69.5	30.8	66.4
40	62.2	27.6	60.2			
50	63.2	33.0	61.9			
63	61.7	35.5	60.9	68.1	43.4	67.3
80	64.7	42.2	64.2			
100	66.8	47.7	66.5			
125	69.1	53.0	68.9	73.9	58.9	73.7
160	70.6	57.2	70.5			
200	69.7	58.8	69.7			
250	65.5	56.9	65.5	71.4	61.8	71.4
315	60.7	54.1	60.7			
400	59.8	55.0	59.8			
500	60.0	56.8	60.0	64.5	61.4	64.5
630	59.5	57.6	59.5			
800	60.4	59.6	60.4			
1000	59.1	59.1	59.1	63.8	63.6	63.8
1250	57.1	57.7	57.1			
1600	55.6	56.6	55.5			
2000	52.3	53.5	52.1	58.2	59.3	58.0
2500	50.8	52.1	50.5			
3150	49.0	50.2	48.5			
4000	46.2	47.2	45.4	51.7	52.7	51.0
5000	44.0	44.5	42.7			
6300	41.5	41.4	39.5			
8000	39.0	37.9	36.0	44.5	43.7	41.8
10000	37.6	35.0	33.2			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 78.2 dB OASLA = 68.5 dB(A)

OASLC = 77.3 dB(C) C-A VALUE = +8.8

Figure 4: Hill AFB Depot Armament Repair Building.
Measurement Location: Center of Bomb Rack Repair Area.
Measurement Conditions: Spray Paint Booth Operating.

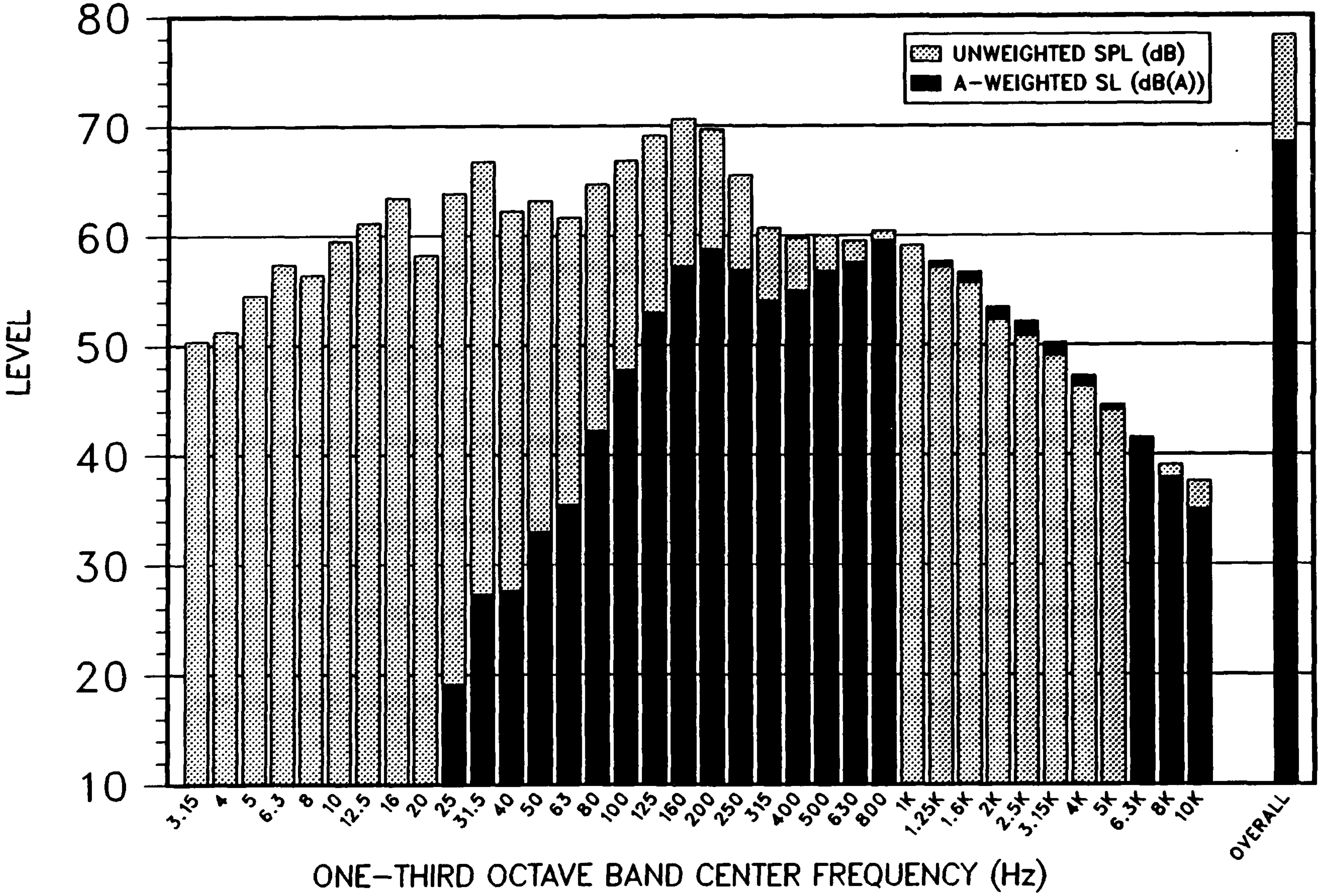


Table 5: Hill AFB Depot Armament Repair Building.
Measurement Location: ALCM Repair Area.
Measurement Conditions: Spray Paint Booth Operating.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	48.3	0.0	0.0			
4	53.4	0.0	0.0	56.8	0.0	0.0
5	52.9	0.0	0.0			
6.3	47.2	0.0	0.0			
8	53.9	0.0	0.0	59.6	4.8	43.6
10	57.9	0.0	43.6			
12.5	49.1	0.0	37.9			
16	49.5	0.0	41.0	55.7	5.8	48.2
20	53.0	2.5	46.8			
25	54.3	9.6	49.9			
31.5	51.8	12.4	48.8	57.1	17.8	53.7
40	49.9	15.3	47.9			
50	50.0	19.8	48.7			
63	46.2	20.0	45.4	53.5	28.1	52.6
80	49.1	26.6	48.6			
100	49.9	30.8	49.6			
125	55.6	39.5	55.4	58.6	43.5	58.5
160	54.3	40.9	54.2			
200	54.0	43.1	54.0			
250	49.8	41.2	49.8	55.9	46.3	55.9
315	46.2	39.6	46.2			
400	45.1	40.3	45.1			
500	46.6	43.4	46.6	50.6	47.5	50.6
630	45.7	43.8	45.7			
800	45.8	45.0	45.8			
1000	43.8	43.8	43.8	49.0	48.7	49.0
1250	42.2	42.8	42.2			
1600	40.7	41.7	40.6			
2000	38.0	39.2	37.8	43.6	44.7	43.4
2500	36.7	38.0	36.4			
3150	35.4	36.6	34.9			
4000	34.2	35.2	33.4	39.4	40.3	38.6
5000	34.1	34.6	32.8			
6300	33.9	33.8	31.9			
8000	34.1	33.0	31.1	38.7	37.6	35.7
10000	33.9	31.4	29.5			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 65.9 dB   OASLA = 53.9 dB(A)
OASLC = 62.6 dB(C)   C-A VALUE = +8.7

Figure 5: Hill AFB Depot Armament Repair Building.
Measurement Location: ALCM Repair Area.
Measurement Conditions: Spray Paint Booth Operating.

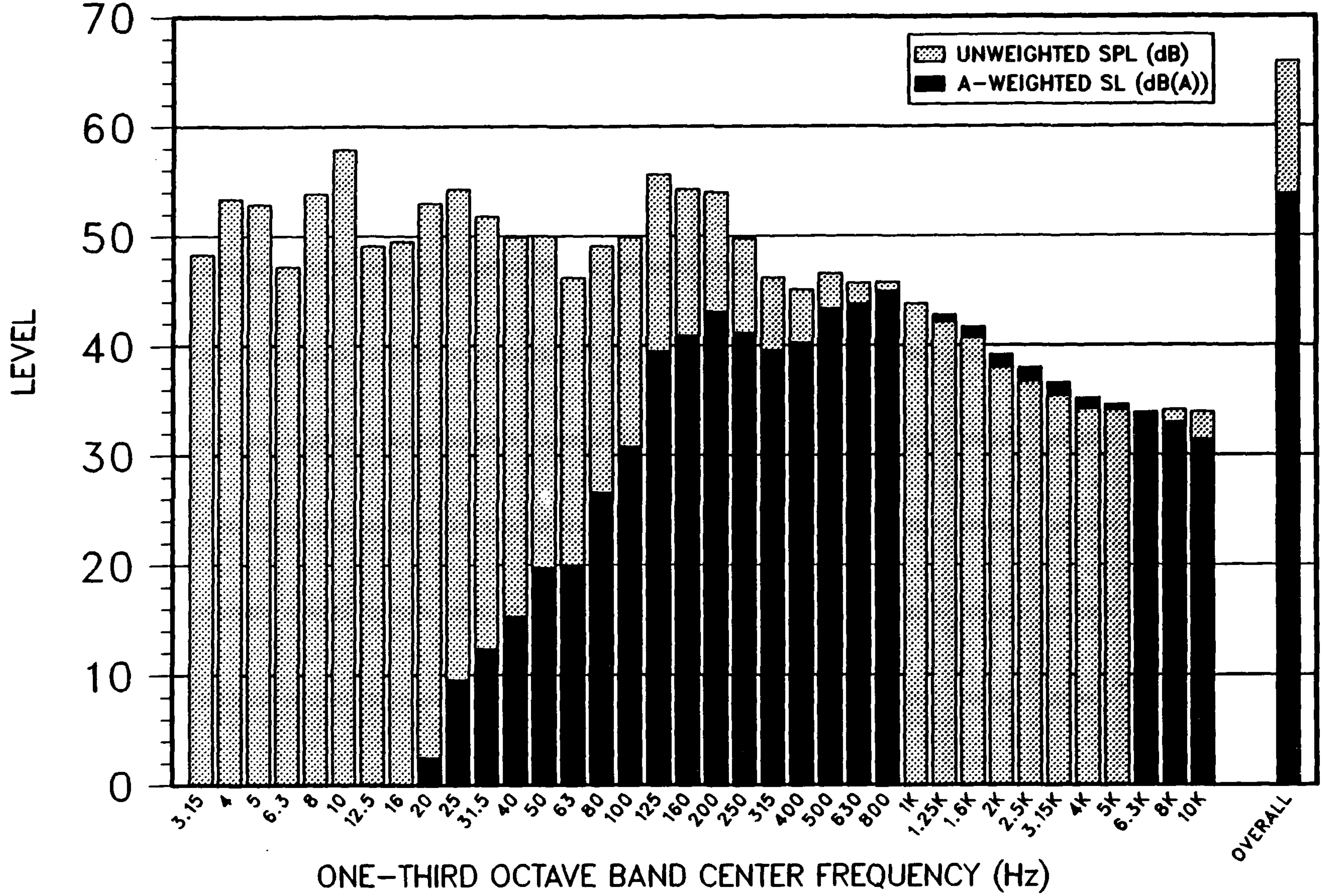


Table 6: Hill AFB Depot Armament Repair Building.
Measurement Location: North End of Main Bay.
Measurement Conditions: Spray Paint Booth Operating.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	50.8	0.0	0.0			
4	50.5	0.0	0.0	56.5	0.0	0.0
5	53.3	0.0	0.0			
6.3	50.6	0.0	0.0			
8	52.7	0.0	0.0	61.7	4.8	46.4
10	60.7	0.0	46.4			
12.5	60.7	0.0	49.4			
16	62.1	5.4	53.6	67.9	15.4	60.5
20	65.3	14.8	59.1			
25	64.9	20.2	60.5			
31.5	68.8	29.4	65.7	70.9	32.1	67.8
40	62.6	28.0	60.6			
50	62.7	32.5	61.4			
63	58.3	32.1	57.6	66.7	41.9	65.9
80	63.3	40.8	62.8			
100	64.1	45.0	63.8			
125	66.3	50.2	66.1	70.4	55.1	70.2
160	66.1	52.7	66.0			
200	64.3	53.4	64.3			
250	60.5	51.9	60.5	66.5	57.0	66.5
315	57.7	51.1	57.7			
400	54.8	50.0	54.8			
500	54.6	51.4	54.6	59.3	56.1	59.3
630	54.1	52.2	54.1			
800	54.5	53.7	54.5			
1000	53.5	53.5	53.5	58.3	58.2	58.3
1250	52.4	53.0	52.4			
1600	50.9	51.9	50.8			
2000	47.3	48.5	47.1	53.3	54.4	53.1
2500	45.4	46.7	45.2			
3150	43.3	44.6	42.8			
4000	40.7	41.7	39.9	46.2	47.2	45.4
5000	38.9	39.4	37.7			
6300	37.0	36.9	35.0			
8000	36.4	35.3	33.4	41.4	40.3	38.4
10000	36.2	33.8	31.9			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 76.3 dB — OASLA = 63.5 dB(A)
OASLC = 74.4 dB(C) — C-A VALUE = +10.9

Figure 6: Hill AFB Depot Armament Repair Building.
Measurement Location: North End of Main Bay.
Measurement Conditions: Spray Paint Booth Operating.

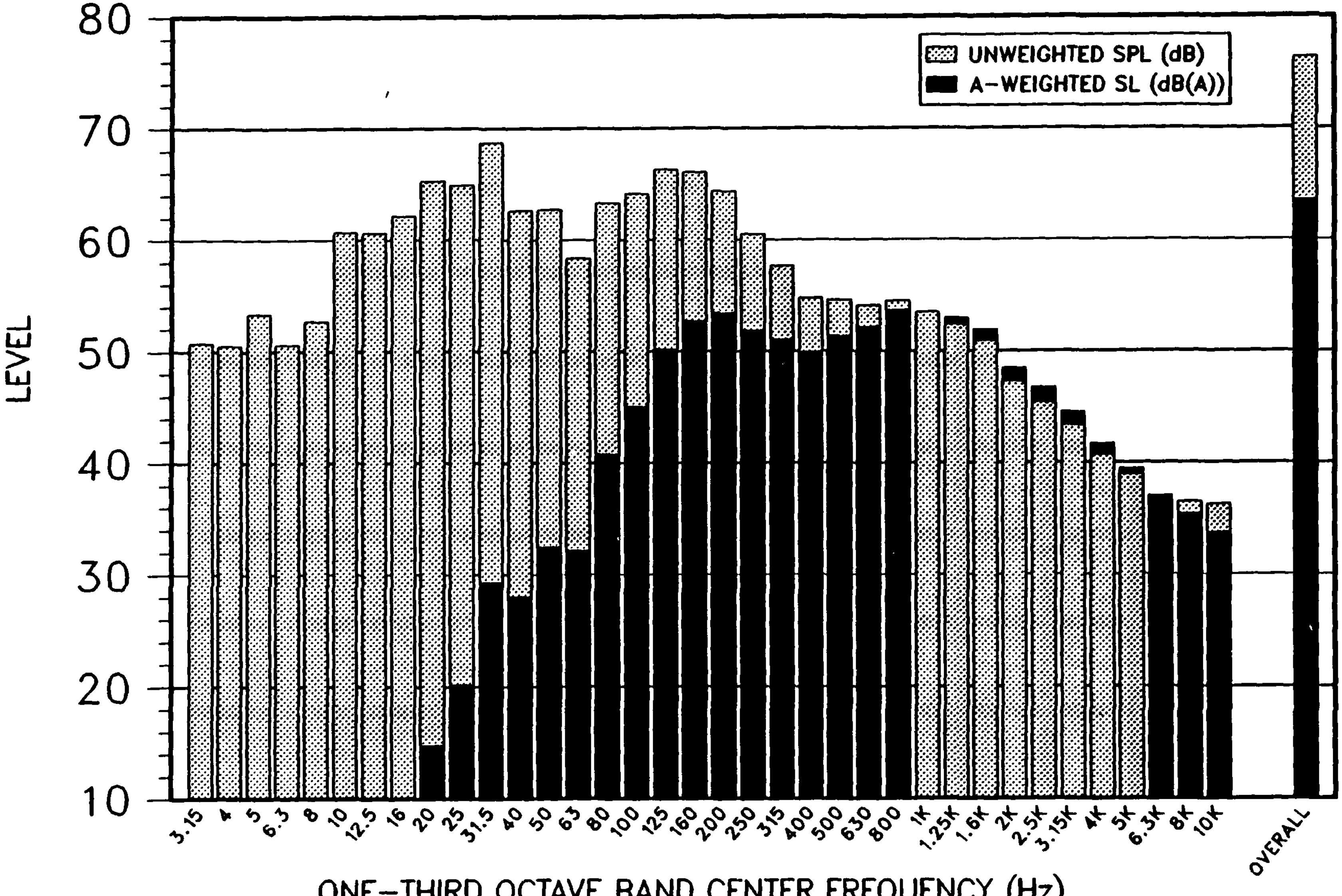


Table 7: Hill AFB Depot Armament Repair Building.
Measurement Location: Gun Repair - Aisle #1.
Measurement Conditions: Normal Operations.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	51.6	0.0	0.0			
4	58.8	0.0	0.0	62.6	0.0	0.0
5	59.6	0.0	0.0			
6.3	55.2	0.0	0.0			
8	58.0	0.0	0.0	60.9	4.8	40.3
10	54.6	0.0	40.3			
12.5	55.5	0.0	44.3			
16	60.8	4.1	52.3	64.4	11.6	56.9
20	60.8	10.3	54.6			
25	57.9	13.2	53.5			
31.5	67.7	28.4	64.7	68.8	30.3	65.9
40	60.1	25.5	58.1			
50	60.1	29.9	58.8			
63	56.3	30.0	55.4	62.7	36.4	61.7
80	56.3	33.8	55.8			
100	60.2	41.0	59.9			
125	65.8	49.7	65.6	67.4	51.4	67.2
160	58.5	45.1	58.4			
200	59.9	49.0	59.9			
250	57.4	48.8	57.4	62.7	53.5	62.7
315	54.9	48.3	54.9			
400	56.1	51.3	56.1			
500	56.0	52.8	56.0	60.8	57.7	60.8
630	56.0	54.1	56.0			
800	54.7	53.9	54.7			
1000	56.0	56.0	56.0	60.3	60.4	60.3
1250	55.9	56.5	55.9			
1600	55.5	56.5	55.4			
2000	56.4	57.6	56.2	60.2	61.4	60.0
2500	54.1	55.4	53.8			
3150	54.6	55.8	54.1			
4000	54.3	55.3	53.5	58.9	59.9	58.1
5000	53.3	53.8	52.0			
6300	49.5	49.4	47.5			
8000	46.3	45.2	43.2	52.0	51.3	49.4
10000	44.1	41.5	39.7			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 74.3 dB   OASLA = 66.6 dB(A)

OASLC = 72.3 dB(C)   C-A VALUE = +5.8

Figure 7: Hill AFB Depot Armament Repair Building.
Measurement Location: Gun Repair – Aisle #1.
Measurement Conditions: Normal Operations.

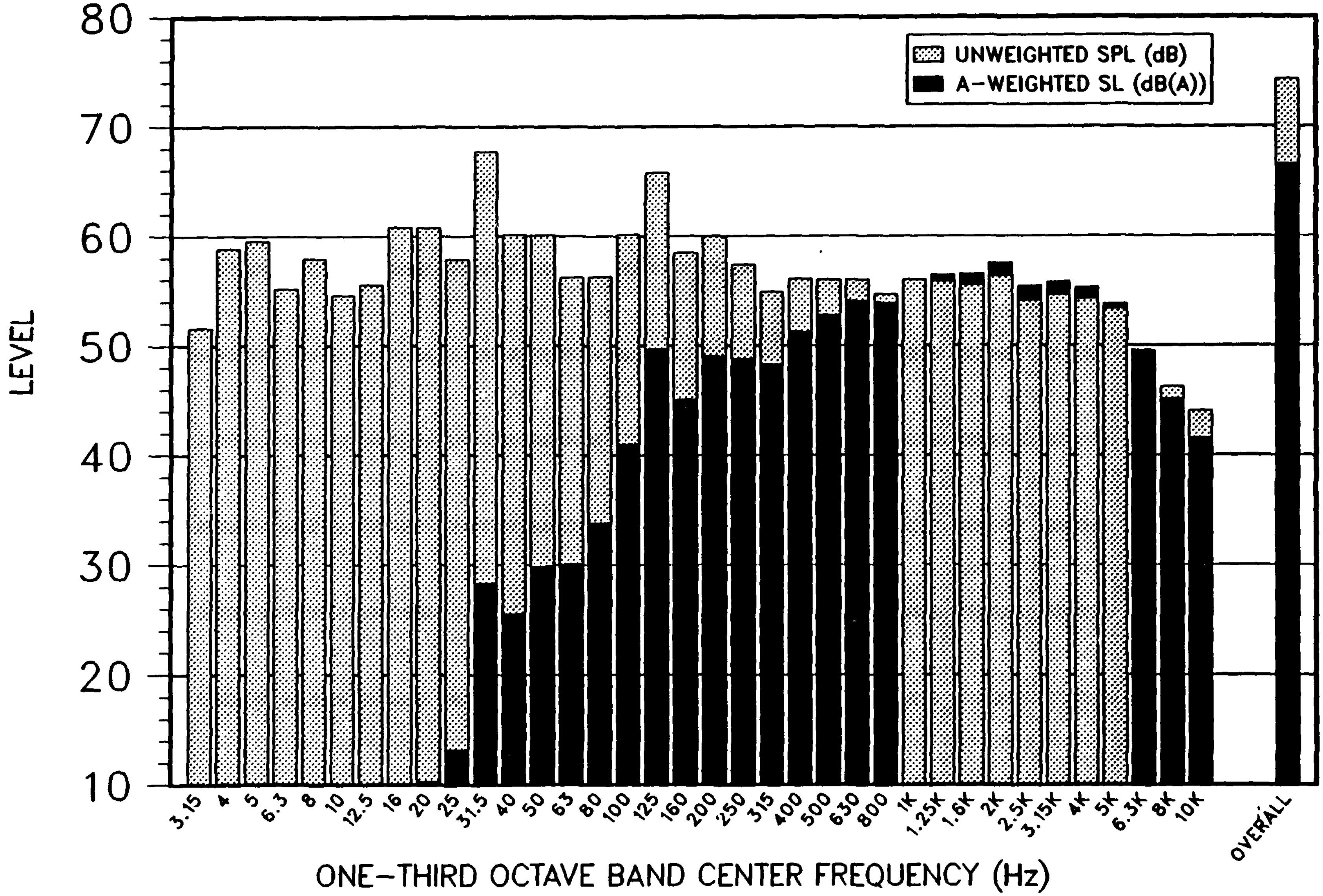


Table 8: Hill AFB Depot Armament Repair Building.
Measurement Location: Gun Repair - Aisle #2.
Measurement Conditions: Normal Operations.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	54.3	0.0	0.0			
4	61.0	0.0	0.0	64.0	0.0	0.0
5	59.8	0.0	0.0			
6.3	53.9	0.0	0.0			
8	52.6	0.0	0.0	57.8	4.8	38.0
10	52.3	0.0	38.0			
12.5	62.2	0.0	50.9			
16	69.9	13.2	61.4	71.7	17.1	63.6
20	65.1	14.6	58.9			
25	61.3	16.6	56.9			
31.5	66.1	26.7	63.1	68.4	30.2	65.4
40	61.7	27.1	59.7			
50	63.3	33.1	62.0			
63	61.9	35.7	61.2	66.4	39.9	65.4
80	58.4	35.9	57.9			
100	60.8	41.6	60.5			
125	62.9	46.8	62.7	66.1	50.2	65.9
160	59.6	46.2	59.5			
200	60.7	49.8	60.7			
250	58.9	50.3	58.9	64.1	55.3	64.1
315	57.8	51.2	57.8			
400	58.7	53.9	58.7			
500	56.7	53.5	56.7	62.6	59.3	62.6
630	57.8	55.9	57.8			
800	55.0	54.2	55.0			
1000	55.2	55.2	55.2	59.7	59.6	59.7
1250	54.5	55.1	54.5			
1600	52.7	53.7	52.6			
2000	52.3	53.5	52.1	56.8	58.0	56.6
2500	50.8	52.1	50.5			
3150	49.6	50.8	49.1			
4000	47.2	48.2	46.4	52.5	53.5	51.7
5000	45.0	45.5	43.7			
6300	42.7	42.6	40.7			
8000	40.3	39.2	37.3	45.9	45.1	43.2
10000	39.7	37.1	35.2			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 75.9 dB　　OASLA = 64.9 dB(A)

OASLC = 72.8 dB(C)　　C-A VALUE = +7.9

Figure 8: Hill AFB Depot Armament Repair Building.
Measurement Location: Gun Repair – Aisle #2.
Measurement Conditions: Normal Operations.

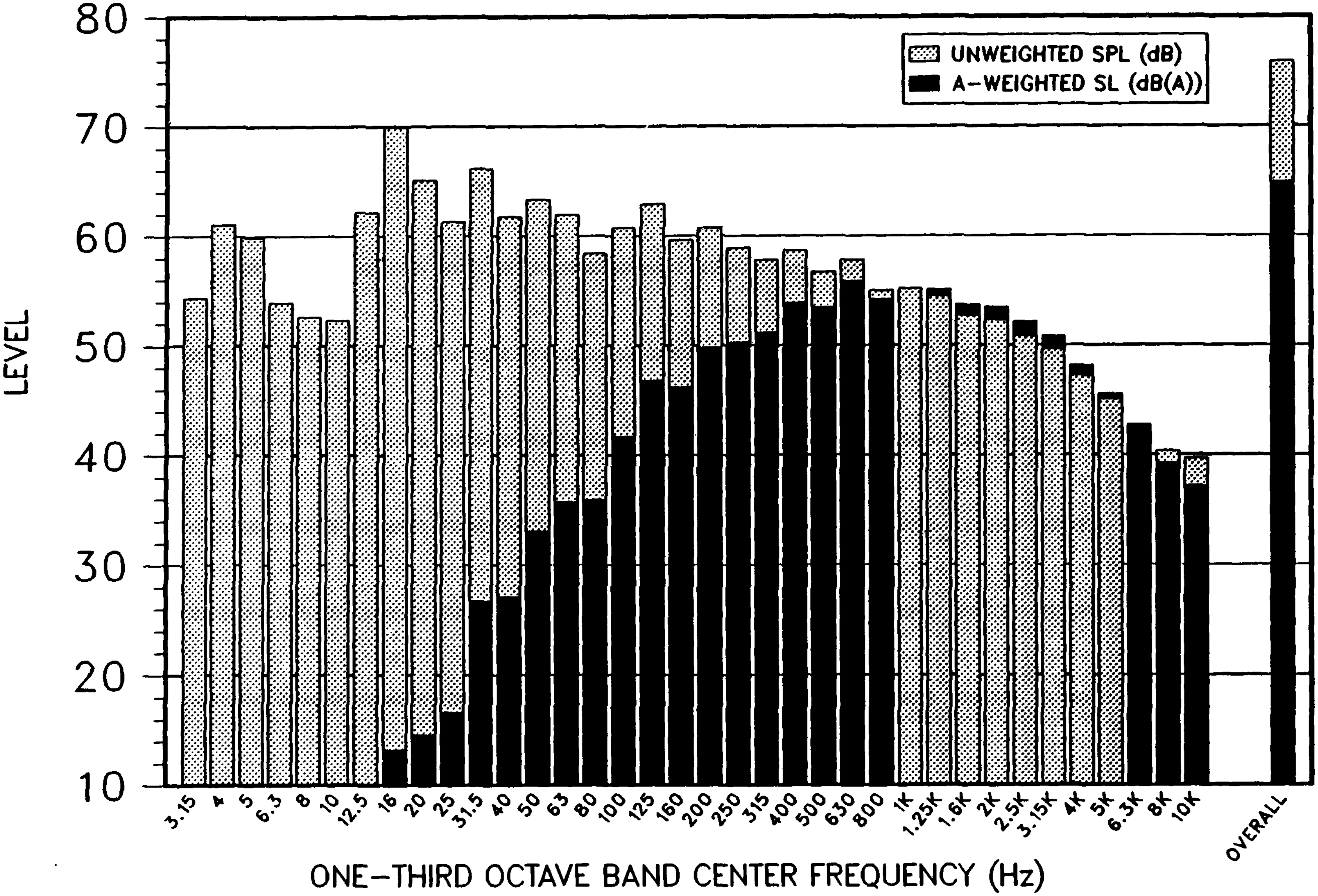


Table 9: Hill AFB Depot Armament Repair Building.
Measurement Location: Gun Repair - Aisle #3.
Measurement Conditions: Normal Operations.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	67.8	0.0	0.0			
4	67.0	0.0	0.0	71.5	0.0	0.0
5	64.5	0.0	0.0			
6.3	62.6	0.0	0.0			
8	63.8	0.0	0.0	67.6	4.8	47.3
10	61.6	0.0	47.3			
12.5	65.9	2.5	54.7			
16	66.2	9.5	57.7	70.8	16.7	62.7
20	66.1	15.6	59.9			
25	62.2	17.5	57.8			
31.5	64.4	25.0	61.4	68.1	30.3	65.1
40	63.0	28.4	61.0			
50	62.2	32.0	60.9			
63	59.0	32.8	58.2	64.7	38.0	63.7
80	57.0	34.5	56.5			
100	62.3	43.2	62.0			
125	64.5	48.4	64.3	67.9	52.3	67.7
160	62.3	48.9	62.2			
200	63.5	52.6	63.5			
250	60.4	51.8	60.4	66.2	57.1	66.2
315	59.1	52.5	59.1			
400	58.2	53.4	58.2			
500	59.3	56.1	59.3	63.4	60.3	63.4
630	58.3	56.4	58.3			
800	56.7	55.9	56.7			
1000	56.7	56.7	56.7	61.1	61.1	61.1
1250	55.6	56.2	55.6			
1600	55.2	56.2	55.1			
2000	53.9	55.1	53.7	58.7	59.9	58.6
2500	52.2	53.5	51.9			
3150	51.6	52.8	51.1			
4000	48.4	49.4	47.6	54.1	55.2	53.4
5000	46.3	46.8	45.0			
6300	43.9	43.8	41.9			
8000	42.4	41.3	39.4	47.3	46.4	44.5
10000	40.4	37.9	36.0			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 77.5 dB   OASLA = 66.4 dB(A)
OASLC = 73.4 dB(C)   C-A VALUE = +7.0

Figure 9: Hill AFB Depot Armament Repair Building.
Measurement Location: Gun Repair – Aisle #3.
Measurement Conditions: Normal Operations.

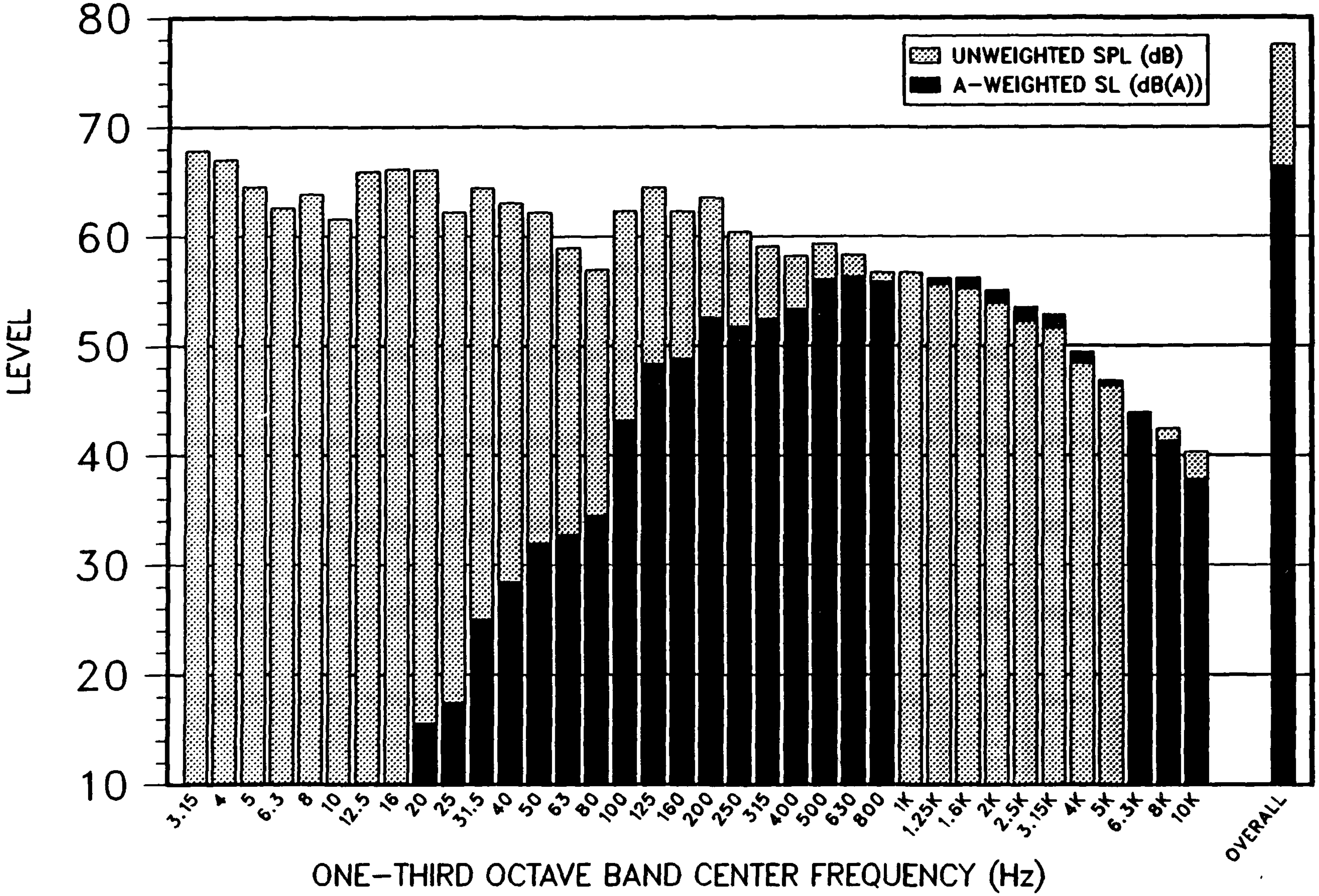


Table 10: Hill AFB Depot Armament Repair Building.
Measurement Location: Gun Repair - Aisle #4.
Measurement Conditions: Normal Operations.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	51.0	0.0	0.0			
4	60.3	0.0	0.0	62.4	0.0	0.0
5	57.1	0.0	0.0			
6.3	50.0	0.0	0.0			
8	57.2	0.0	0.0	60.4	4.8	42.4
10	56.7	0.0	42.4			
12.5	54.3	0.0	43.1			
16	65.7	9.0	57.2	69.7	17.6	62.7
20	67.4	16.9	61.2			
25	62.9	18.2	58.5			
31.5	65.9	26.5	62.9	68.5	29.8	65.4
40	61.0	26.4	59.1			
50	60.2	30.0	58.9			
63	58.2	32.0	57.4	63.0	36.3	62.0
80	54.9	32.4	54.4			
100	61.9	42.8	61.7			
125	65.4	49.3	65.2	67.9	51.9	67.6
160	60.3	46.9	60.2			
200	59.7	48.8	59.7			
250	58.8	50.2	58.8	63.1	54.0	63.1
315	55.0	48.4	55.0			
400	56.3	51.5	56.3			
500	56.2	53.0	56.2	61.4	58.4	61.4
630	57.4	55.5	57.4			
800	55.9	55.1	55.9			
1000	56.0	56.0	56.0	60.6	60.6	60.6
1250	55.6	56.2	55.6			
1600	54.4	55.4	54.3			
2000	53.6	54.8	53.4	58.5	59.7	58.3
2500	53.1	54.4	52.8			
3150	52.8	54.0	52.3			
4000	51.0	52.0	50.2	55.8	56.8	55.0
5000	47.6	48.1	46.3			
6300	44.6	44.4	42.5			
8000	41.7	40.6	38.8	47.2	46.5	44.6
10000	39.8	37.2	35.4			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 75.2 dB　　OASLA = 65.7 dB(A)

OASLC = 72.6 dB(C)　　C-A VALUE = +7.0

Figure 10: Hill AFB Depot Armament Repair Building.
Measurement Location: Gun Repair – Aisle #4.
Measurement Conditions: Normal Operations.

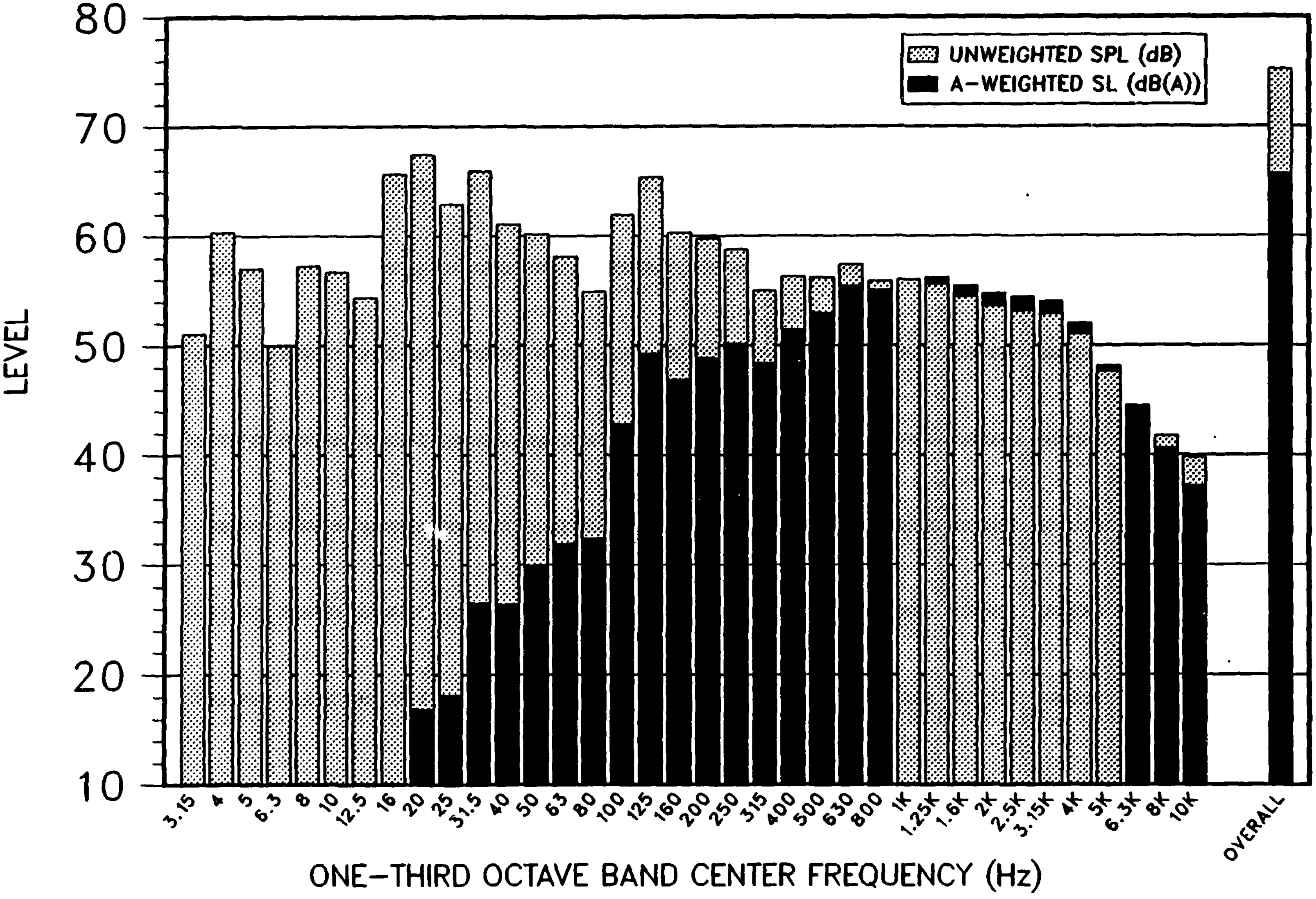


Table 11: Hill AFB Depot Armament Repair Building.
Measurement Location: F-4 Seat Repair Area.
Measurement Conditions: Normal Operations.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	58.8	0.0	0.0			
4	59.1	0.0	0.0	62.5	0.0	0.0
5	53.3	0.0	0.0			
6.3	51.2	0.0	0.0			
8	58.0	0.0	0.0	60.0	4.8	39.6
10	53.9	0.0	39.6			
12.5	52.1	0.0	40.9			
16	48.1	0.0	39.6	59.9	9.3	53.0
20	58.7	8.2	52.5			
25	63.1	18.4	58.7			
31.5	52.9	13.5	49.9	64.1	23.2	60.2
40	55.2	20.6	53.2			
50	54.7	24.5	53.4			
63	53.8	27.6	53.0	58.8	33.2	57.9
80	53.4	30.9	52.9			
100	58.2	39.0	57.9			
125	59.7	43.6	59.5	65.1	50.2	64.9
160	62.1	48.7	62.0			
200	56.6	45.7	56.6			
250	55.4	46.8	55.4	60.9	52.5	60.9
315	56.3	49.7	56.3			
400	57.6	52.8	57.6			
500	59.4	56.2	59.4	64.5	61.8	64.5
630	61.4	59.5	61.4			
800	58.6	57.8	58.6			
1000	58.2	58.2	58.2	62.8	62.7	62.8
1250	57.1	57.7	57.1			
1600	55.8	56.9	55.7			
2000	55.5	56.7	55.3	60.1	61.2	59.9
2500	54.4	55.7	54.1			
3150	54.6	55.8	54.1			
4000	57.5	58.5	56.7	62.5	63.3	61.5
5000	59.7	60.2	58.5			
6300	60.2	60.1	58.2			
8000	61.4	60.3	58.5	66.0	64.7	62.8
10000	61.8	59.3	57.4			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 73.6 dB   OASLA = 70.0 dB(A)

OASLC = 71.8 dB(C)   C-A VALUE = +1.8

Figure 11: Hill AFB Depot Armament Repair Building.
Measurement Location: F–4 Seat Repair Area.
Measurement Conditions: Normal Operations.

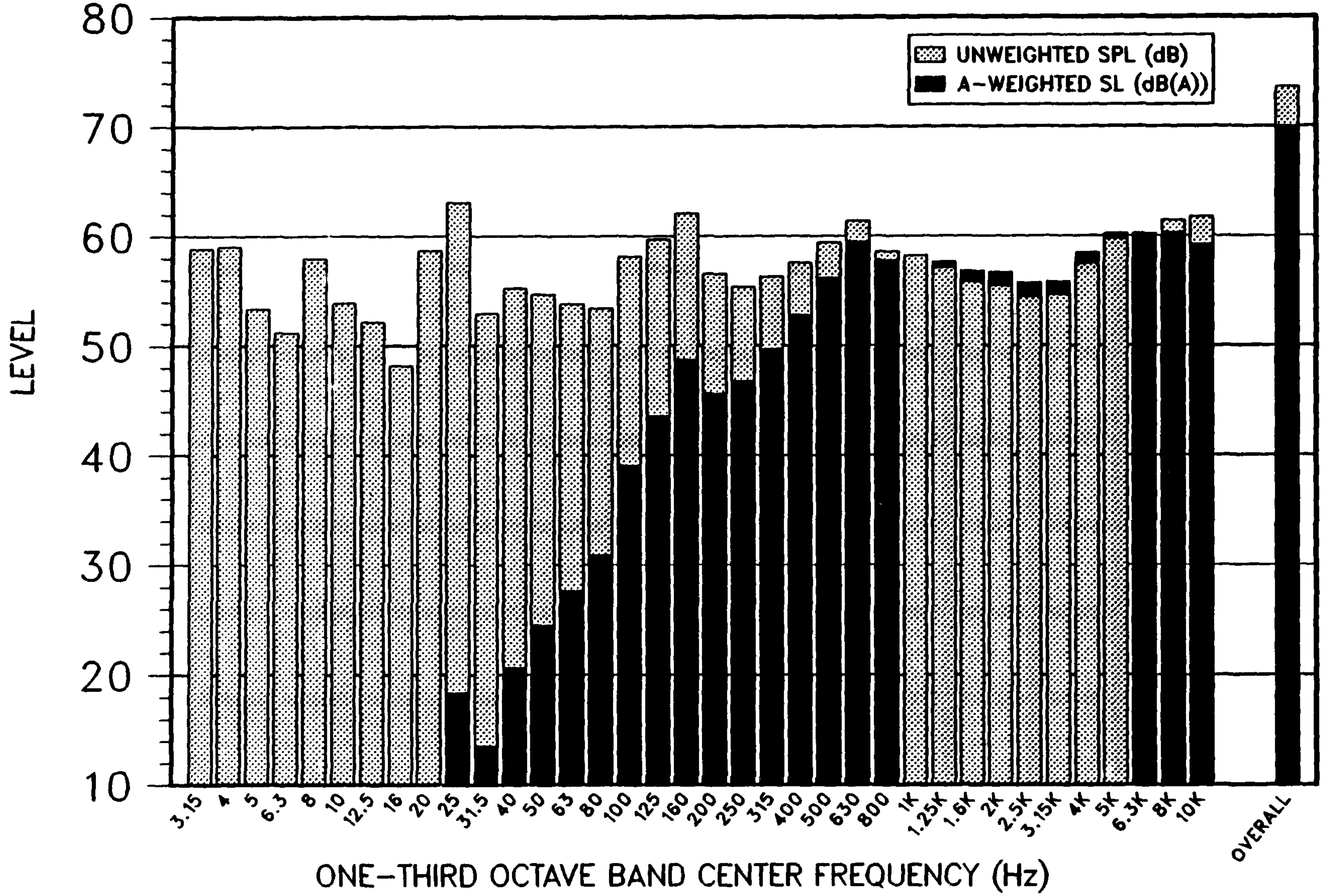


Table 12: Hill AFB Depot Armament Repair Building.
Measurement Location: F-16 Seat Repair Area.
Measurement Conditions: Normal Operations.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	55.1	0.0	0.0			
4	54.5	0.0	0.0	59.4	0.0	0.0
5	54.2	0.0	0.0			
6.3	52.4	0.0	0.0			
8	61.4	0.0	0.0	62.8	4.8	40.9
10	55.2	0.0	40.9			
12.5	47.4	0.0	36.1			
16	52.8	0.0	44.3	55.5	4.8	47.6
20	50.3	0.0	44.1			
25	58.2	13.5	53.8			
31.5	56.2	16.8	53.2	63.3	26.4	60.5
40	60.2	25.6	58.2			
50	53.0	22.8	51.7			
63	50.3	24.1	49.5	57.4	32.6	56.6
80	53.8	31.3	53.3			
100	56.3	37.1	55.9			
125	57.9	41.8	57.7	64.6	50.2	64.5
160	62.7	49.3	62.6			
200	51.6	40.7	51.6			
250	51.9	43.3	51.9	57.1	49.0	57.1
315	53.2	46.6	53.2			
400	53.2	48.4	53.2			
500	55.9	52.7	55.9	60.4	57.6	60.4
630	57.0	55.1	57.0			
800	50.9	50.1	50.9			
1000	48.1	48.1	48.1	54.2	54.0	54.2
1250	48.7	49.3	48.7			
1600	48.4	49.4	48.3			
2000	46.1	47.3	45.9	51.8	52.9	51.6
2500	45.9	47.2	45.7			
3150	44.5	45.7	44.0			
4000	42.8	43.8	42.0	48.2	49.2	47.4
5000	42.6	43.1	41.3			
6300	40.9	40.8	38.9			
8000	40.0	38.9	37.0	45.1	44.1	42.2
10000	40.0	37.5	35.6			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 70.4 dB　　OASLA = 61.2 dB(A)

OASLC = 68.1 dB(C)　　C-A VALUE = +6.9

Figure 12: Hill AFB Depot Armament Repair Building.
Measurement Location: F-16 Seat Repair Area.
Measurement Conditions: Normal Operations.

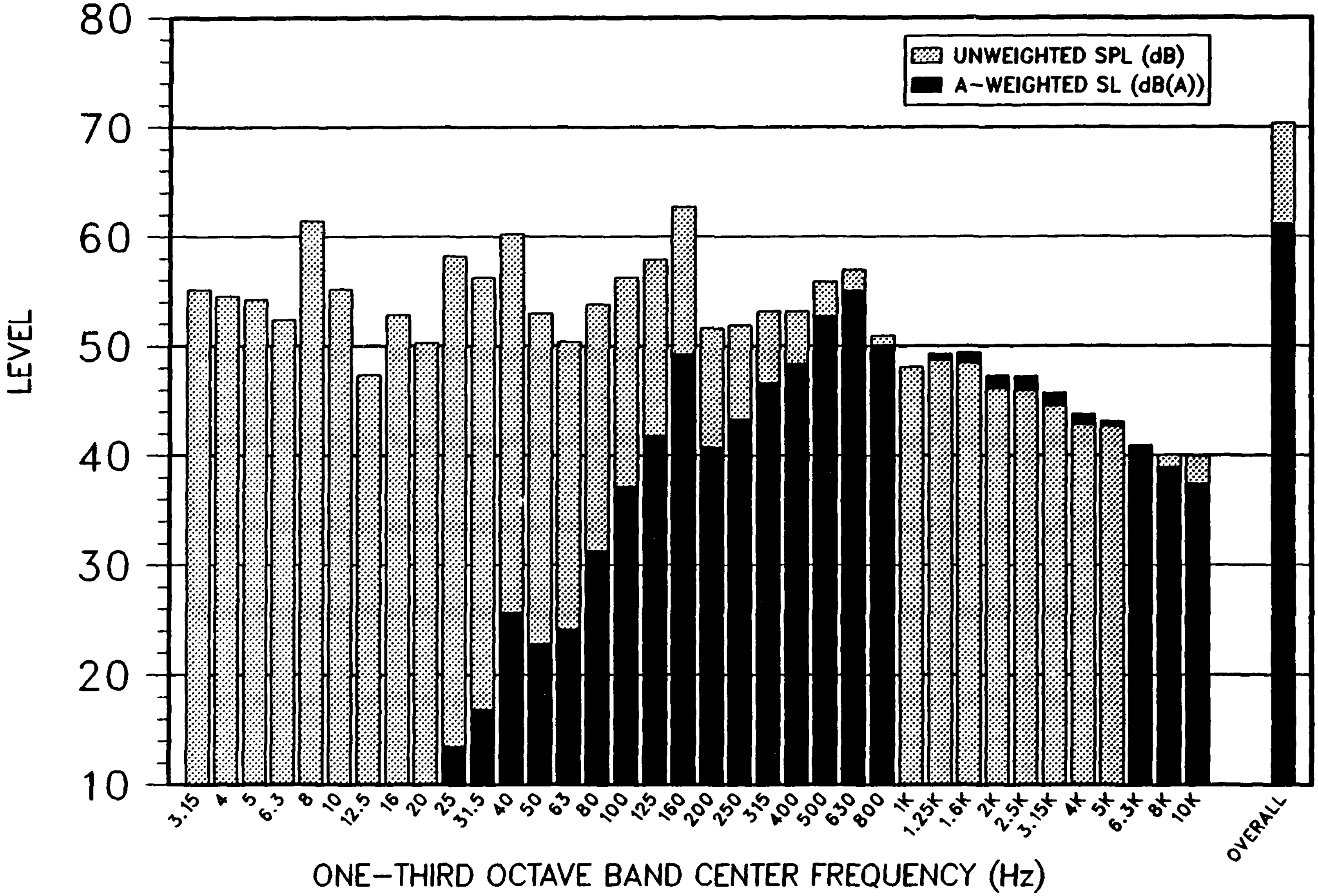


Table 13: Hill AFB Depot Armament Repair Building.
Measurement Location: Steam Cleaning Operation Outside of Seat Repair Area.
Measurement Conditions: Background Noise with Steam Cleaning Operation Turned Off.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	57.0	0.0	0.0			
4	53.6	0.0	0.0	59.6	0.0	0.0
5	52.8	0.0	0.0			
6.3	58.9	0.0	0.0			
8	68.8	0.0	0.0	69.9	4.8	47.6
10	61.9	0.0	47.6			
12.5	60.6	0.0	49.3			
16	51.0	0.0	42.5	62.3	7.8	53.2
20	56.5	6.0	50.3			
25	62.2	17.5	57.8			
31.5	66.2	26.9	63.3	68.0	28.3	64.7
40	55.9	21.3	53.9			
50	60.7	30.5	59.4			
63	54.0	27.8	53.2	63.3	37.6	62.4
80	58.6	36.1	58.1			
100	56.6	37.4	56.3			
125	58.2	42.1	58.0	62.6	47.3	62.4
160	58.4	45.0	58.3			
200	59.3	48.4	59.3			
250	55.9	47.3	55.9	62.0	52.9	62.0
315	55.1	48.5	55.1			
400	54.7	49.9	54.7			
500	56.7	53.5	56.7	60.4	57.3	60.4
630	55.2	53.3	55.2			
800	54.3	53.5	54.3			
1000	54.8	54.8	54.8	59.2	59.1	59.2
1250	54.0	54.6	54.0			
1600	52.2	53.2	52.1			
2000	52.1	53.3	51.9	56.3	57.4	56.1
2500	49.8	51.1	49.5			
3150	48.3	49.5	47.8			
4000	47.4	48.4	46.6	52.7	53.6	51.8
5000	47.9	48.4	46.6			
6300	44.9	44.8	42.9			
8000	44.6	43.4	41.5	49.0	48.0	46.1
10000	43.0	40.5	38.6			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 74.3 dB   OASLA = 63.9 dB(A)

OASLC = 70.3 dB(C)   C-A VALUE = +6.4

Figure 13: Hill AFB Depot Armament Repair Building.
Measurement Location: Steam Cleaning Outside of Seat Repair Area.
Measurement Conditions: Background Noise with Steam Cleaning Off.

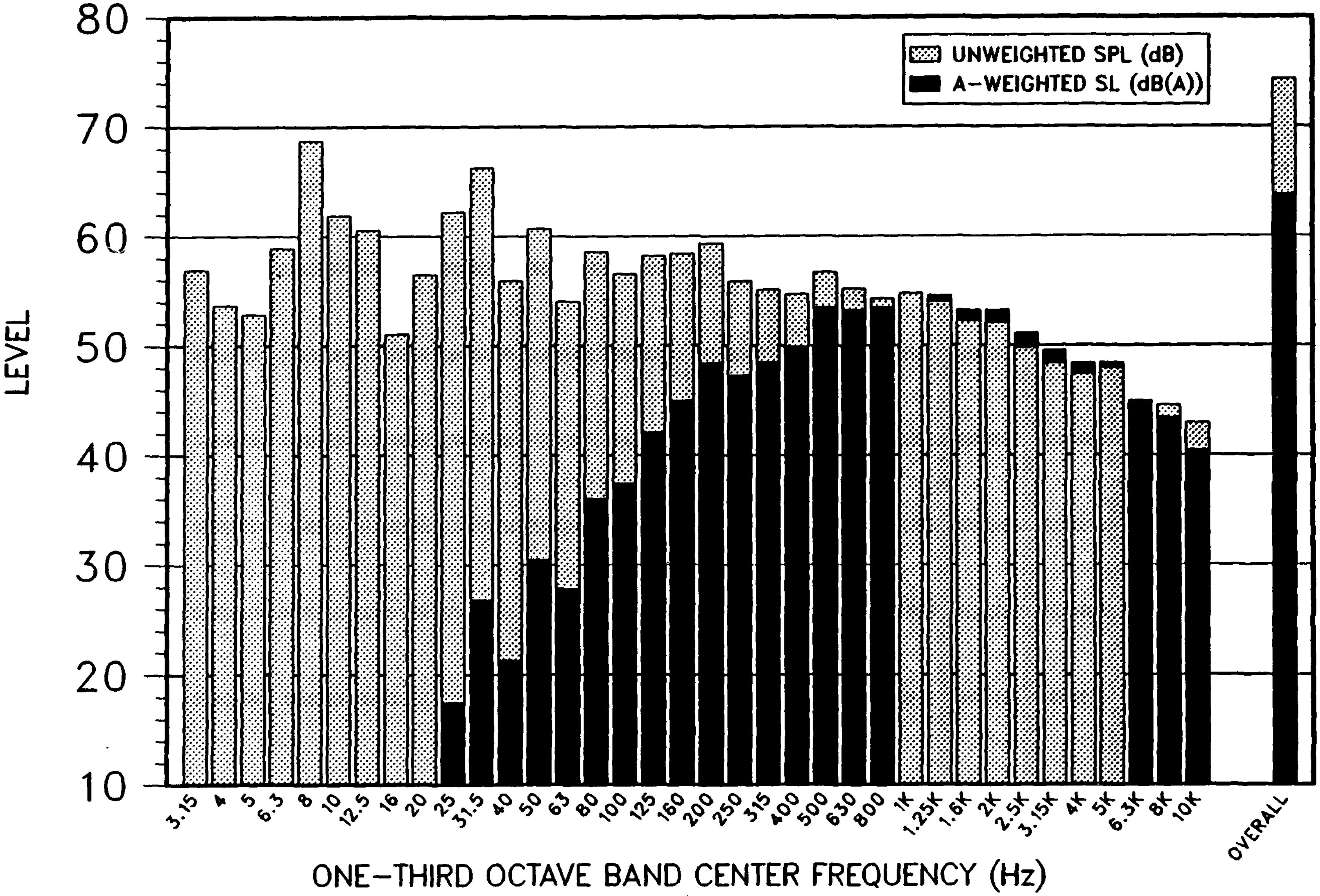


Table 14: Hill AFB Depot Armament Repair Building.
Measurement Location: Steam Cleaning Operation Outside of Seat Repair Area.
Measurement Conditions: Steam Cleaning Operation Start-Up

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	66.0	0.0	0.0			
4	61.4	0.0	0.0	67.6	0.0	0.0
5	57.1	0.0	0.0			
6.3	60.7	0.0	0.0			
8	69.4	0.0	0.0	70.6	4.8	48.0
10	62.3	0.0	48.0			
12.5	61.9	0.0	50.7			
16	54.7	0.0	46.2	63.8	8.3	54.6
20	57.3	6.8	51.1			
25	62.5	17.8	58.1			
31.5	66.5	27.1	63.5	68.3	28.8	65.0
40	57.3	22.6	55.2			
50	60.5	30.3	59.2			
63	56.0	29.8	55.2	63.1	36.9	62.1
80	57.2	34.7	56.7			
100	57.0	37.9	56.7			
125	59.3	43.2	59.1	64.1	49.2	63.9
160	60.9	47.5	60.8			
200	62.0	51.1	62.0			
250	62.3	53.7	62.3	67.4	59.3	67.4
315	63.5	56.9	63.5			
400	67.1	62.3	67.1			
500	70.6	67.4	70.6	77.2	74.8	77.2
630	75.5	73.6	75.5			
800	78.3	77.5	78.3			
1000	79.8	79.8	79.8	84.7	84.8	84.7
1250	81.2	81.8	81.2			
1600	86.3	87.3	86.2			
2000	86.4	87.6	86.2	90.4	91.6	90.2
2500	84.0	85.3	83.7			
3150	85.4	86.6	84.9			
4000	85.5	86.5	84.7	90.3	91.2	89.4
5000	85.7	86.2	84.4			
6300	83.9	83.8	81.9			
8000	82.5	81.4	79.5	87.3	86.5	84.6
10000	80.7	78.2	76.3			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 94.9 dB   OASLA = 95.5 dB(A)

OASLC = 94.1 dB(C)   C-A VALUE = -1.4

Figure 14: Hill AFB Depot Armament Repair Building.
Measurement Location: Steam Cleaning Outside of Seat Repair Area.
Measurement Conditions: Steam Cleaning Operation Start–Up.

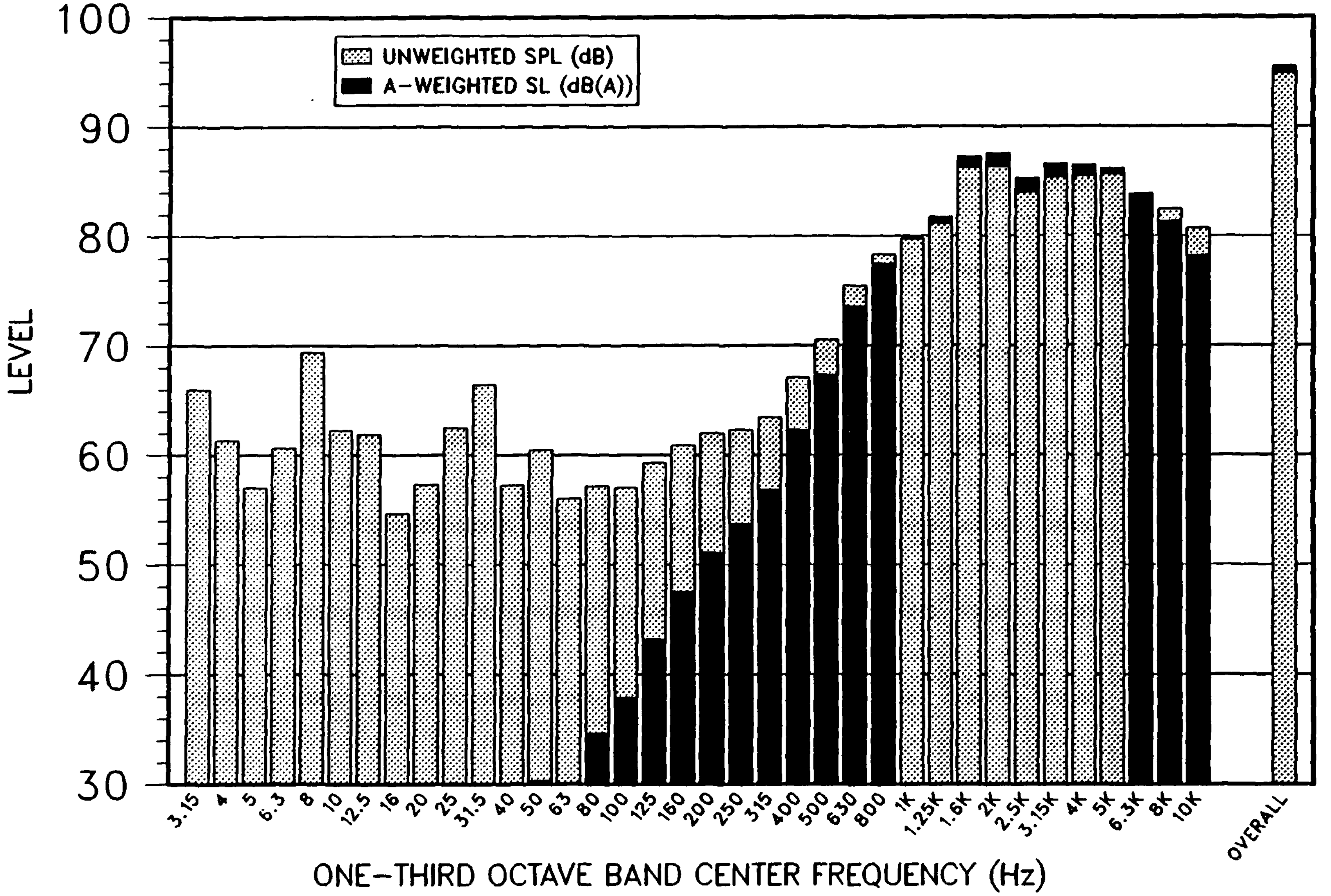


Table 15: Hill AFB Depot Armament Repair Building.
Measurement Location: Steam Cleaning Operation Outside of Seat Repair Area.
Measurement Conditions: Steam Cleaning Under Normal Operation.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	57.2	0.0	0.0			
4	51.0	0.0	0.0	59.8	0.0	0.0
5	54.9	0.0	0.0			
6.3	60.5	0.0	0.0			
8	67.5	0.0	0.0	69.1	4.8	46.8
10	61.1	0.0	46.8			
12.5	61.2	0.0	49.9			
16	49.1	0.0	40.6	62.9	8.4	53.8
20	57.4	6.9	51.2			
25	62.0	17.3	57.6			
31.5	66.5	27.2	63.5	68.1	28.4	64.8
40	55.2	20.6	53.2			
50	57.9	27.7	56.6			
63	48.5	22.3	47.8	60.5	35.1	59.6
80	56.4	33.9	55.9			
100	58.5	39.3	58.2			
125	59.0	42.9	58.8	63.7	48.3	63.5
160	59.3	45.9	59.2			
200	60.6	49.7	60.6			
250	63.0	54.4	63.0	68.4	60.8	68.4
315	65.8	59.2	65.8			
400	66.3	61.5	66.3			
500	67.6	64.4	67.6	72.9	70.1	72.9
630	69.8	67.9	69.8			
800	69.7	68.9	69.7			
1000	69.2	69.2	69.2	74.3	74.2	74.3
1250	69.6	70.2	69.6			
1600	69.2	70.2	69.1			
2000	69.3	70.5	69.1	73.7	74.9	73.5
2500	68.3	69.6	68.0			
3150	66.7	67.9	66.2			
4000	66.0	67.0	65.2	70.9	71.8	70.1
5000	65.6	66.1	64.3			
6300	63.7	63.6	61.7			
8000	60.9	59.8	58.0	66.2	65.6	63.7
10000	58.1	55.5	53.6			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 80.6 dB　　OASLA = 79.4 dB(A)

OASLC = 79.8 dB(C)　　C-A VALUE = +.3

Figure 15: Hill AFB Depot Armament Repair Building.
Measurement Location: Steam Cleaning Outside of Seat Repair Area.
Measurement Conditions: Steam Cleaning Under Normal Operation.

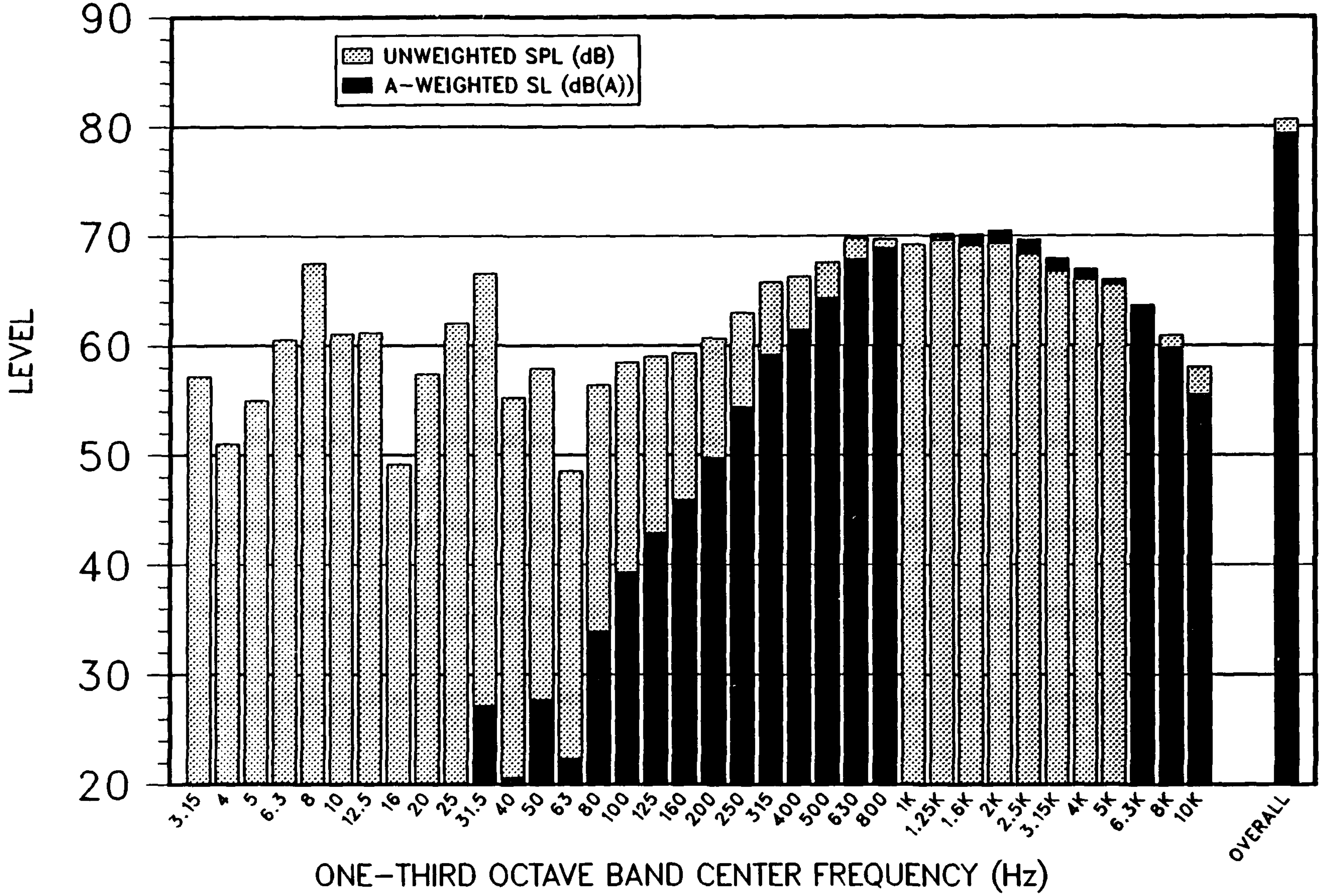


Table 16: Hill AFB Depot Armament Repair Building. Measurement Location: Section 1 of Main Bay Near Administration Area. Measurement Conditions: Background Noise Under Normal Operation.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	60.6	0.0	0.0			
4	58.8	0.0	0.0	64.0	0.0	0.0
5	58.0	0.0	0.0			
6.3	57.3	0.0	0.0			
8	59.0	0.0	0.0	64.0	4.8	46.4
10	60.7	0.0	46.4			
12.5	61.3	0.0	50.0			
16	64.7	8.0	56.2	77.8	27.1	71.5
20	77.5	27.0	71.3			
25	70.9	26.2	66.5			
31.5	77.0	37.6	74.0	78.2	38.7	75.0
40	65.5	30.9	63.5			
50	62.9	32.7	61.6			
63	62.8	36.5	62.0	66.8	40.7	65.9
80	59.8	37.3	59.3			
100	62.8	43.7	62.5			
125	66.6	50.5	66.4	71.5	56.8	71.3
160	68.8	55.4	68.7			
200	68.3	57.5	68.3			
250	62.9	54.3	62.9	70.3	61.0	70.3
315	62.9	56.3	62.9			
400	64.5	59.7	64.5			
500	64.7	61.5	64.7	69.4	66.3	69.4
630	64.8	62.9	64.8			
800	59.9	59.1	59.9			
1000	59.2	59.2	59.2	63.6	63.5	63.6
1250	57.0	57.6	57.0			
1600	57.1	58.1	57.0			
2000	56.8	58.0	56.6	61.1	62.2	60.9
2500	54.4	55.7	54.1			
3150	52.2	53.4	51.7			
4000	49.7	50.7	48.9	55.0	56.0	54.3
5000	47.5	48.0	46.2			
6300	44.7	44.6	42.7			
8000	42.3	41.2	39.3	47.6	46.9	45.0
10000	40.4	37.9	36.0			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 82.4 dB　　　　OASLA = 70.2 dB(A)

OASLC = 79.4 dB(C)　　　　C-A VALUE = +9.2

Figure 16: Hill AFB Depot Armament Repair Building.
Measurement Location: Section 1 of Main Bay Near Administration Area.
Measurement Conditions: Background Noise Under Normal Operation.

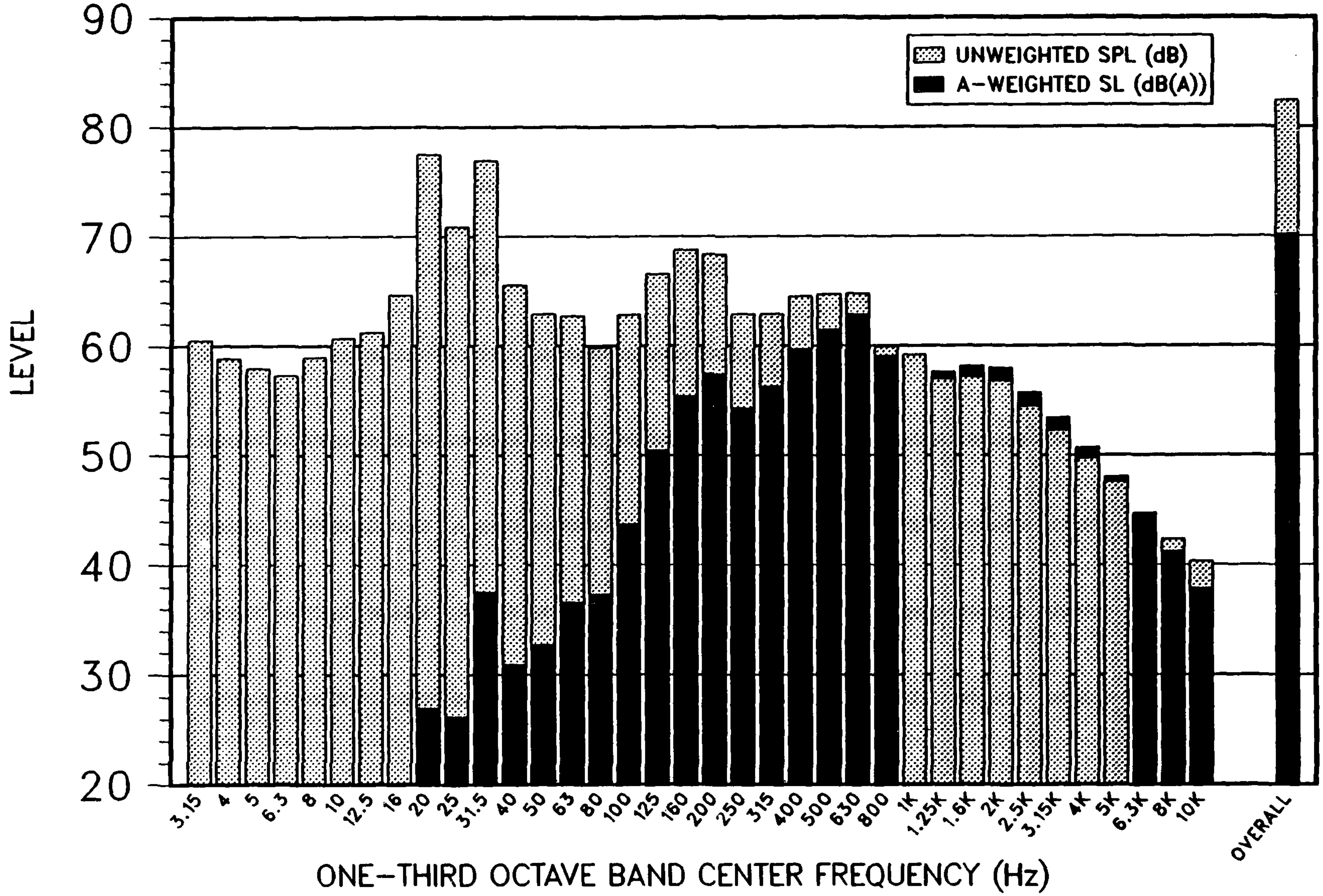


Table 17: Hill AFB Depot Armament Repair Building.
Measurement Location: Section 2 of Main Bay - Bomb Rack Repair.
Measurement Conditions: Background Noise Under Normal Operation.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	61.8	0.0	0.0			
4	62.5	0.0	0.0	66.5	0.0	0.0
5	60.6	0.0	0.0			
6.3	58.4	0.0	0.0			
8	58.8	0.0	0.0	64.4	4.8	46.8
10	61.1	0.0	46.8			
12.5	63.0	0.0	51.8			
16	61.0	4.3	52.5	74.0	23.0	67.5
20	73.4	22.9	67.2			
25	66.3	21.6	61.9			
31.5	71.6	32.2	68.6	73.2	34.0	70.1
40	63.0	28.4	61.0			
50	61.9	31.7	60.6			
63	61.3	35.1	60.6	65.7	39.7	64.8
80	59.2	36.7	58.7			
100	62.3	43.1	62.0			
125	63.9	47.8	63.7	68.5	53.4	68.4
160	64.8	51.4	64.7			
200	66.8	55.9	66.8			
250	62.0	53.4	62.0	69.1	59.9	69.1
315	62.3	55.7	62.3			
400	60.8	56.0	60.8			
500	61.2	58.0	61.2	65.9	62.8	65.9
630	61.3	59.4	61.3			
800	59.8	59.0	59.8			
1000	57.5	57.5	57.5	63.0	62.8	63.0
1250	56.9	57.5	56.9			
1600	56.7	57.7	56.6			
2000	55.4	56.6	55.2	60.6	61.7	60.4
2500	55.0	56.4	54.7			
3150	53.3	54.5	52.8			
4000	49.6	50.6	48.8	55.5	56.6	54.8
5000	46.9	47.4	45.7			
6300	43.9	43.8	41.9			
8000	41.5	40.4	38.5	46.9	46.1	44.2
10000	40.0	37.5	35.6			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 79.0 dB   OASLA = 68.5 dB(A)

OASLC = 76.1 dB(C)   C-A VALUE = +7.7

Figure 17: Hill AFB Depot Armament Repair Building.
Measurement Location: Section 2 of Main Bay – Bomb Rack Repair.
Measurement Conditions: Background Noise Under Normal Operation.

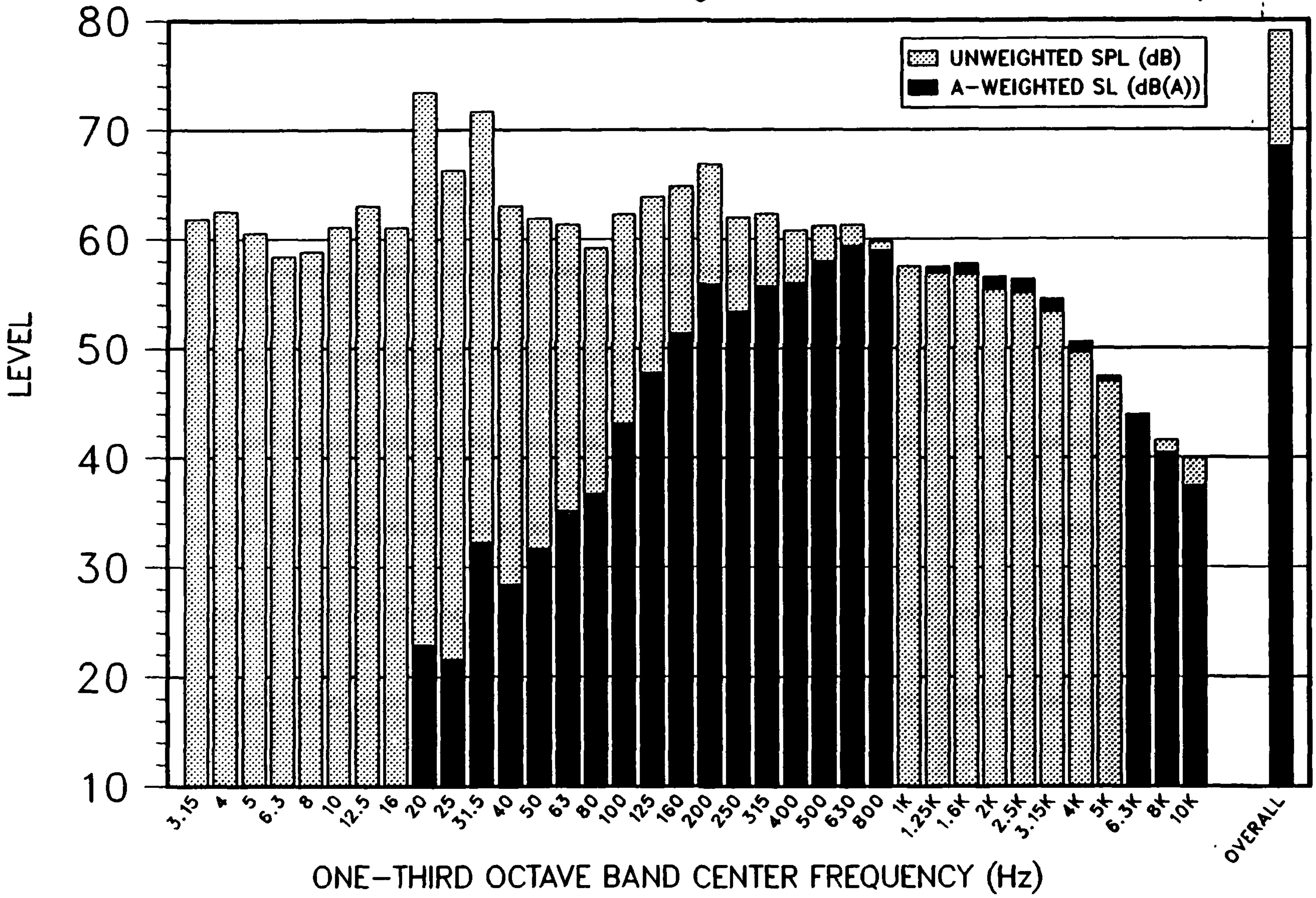


Table 18: Hill AFB Depot Armament Repair Building.
Measurement Location: Section 2 of Main Bay - Bomb Rack Repair.
Measurement Conditions: Pneumatic Air Wrench Noise.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	64.0	0.0	0.0			
4	61.7	0.0	0.0	67.2	0.0	0.0
5	60.8	0.0	0.0			
6.3	59.3	0.0	0.0			
8	58.7	0.0	0.0	64.6	4.8	46.8
10	61.1	0.0	46.3			
12.5	63.3	0.0	52.0			
16	61.5	4.8	53.0	74.3	23.3	67.8
20	73.7	23.2	67.5			
25	66.2	21.5	61.8			
31.5	71.8	32.4	68.9	73.3	34.0	70.1
40	62.6	28.0	60.6			
50	62.1	31.9	60.8			
63	61.0	34.8	60.3	65.6	39.5	64.7
80	58.8	36.3	58.3			
100	61.8	42.6	61.5			
125	64.1	48.0	63.9	68.6	53.6	68.5
160	65.1	51.7	65.0			
200	66.8	55.9	66.8			
250	62.8	54.2	62.8	69.6	60.7	69.6
315	63.7	57.1	63.7			
400	61.7	56.9	61.7			
500	62.7	59.5	62.7	67.2	64.2	67.2
630	62.9	61.0	62.9			
800	62.7	61.9	62.7			
1000	61.1	61.1	61.1	66.5	66.4	66.5
1250	61.1	61.7	61.1			
1600	62.2	63.2	62.1			
2000	63.9	65.1	63.7	67.7	68.8	67.5
2500	62.3	63.6	62.0			
3150	61.9	63.1	61.4			
4000	62.8	63.8	62.0	67.4	68.2	66.5
5000	62.9	63.4	61.7			
6300	61.2	61.1	59.2			
8000	59.3	58.2	56.4	64.5	63.6	61.7
10000	57.8	55.2	53.3			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 80.0 dB OASLA = 74.0 dB(A)

OASLC = 77.5 dB(C) C-A VALUE = +3.6

Figure 18: Hill AFB Depot Armament Repair Building.
Measurement Location: Section 2 of Main Bay – Bomb Rack Repair.
Measurement Conditions: Pneumatic Air Wrench Noise.

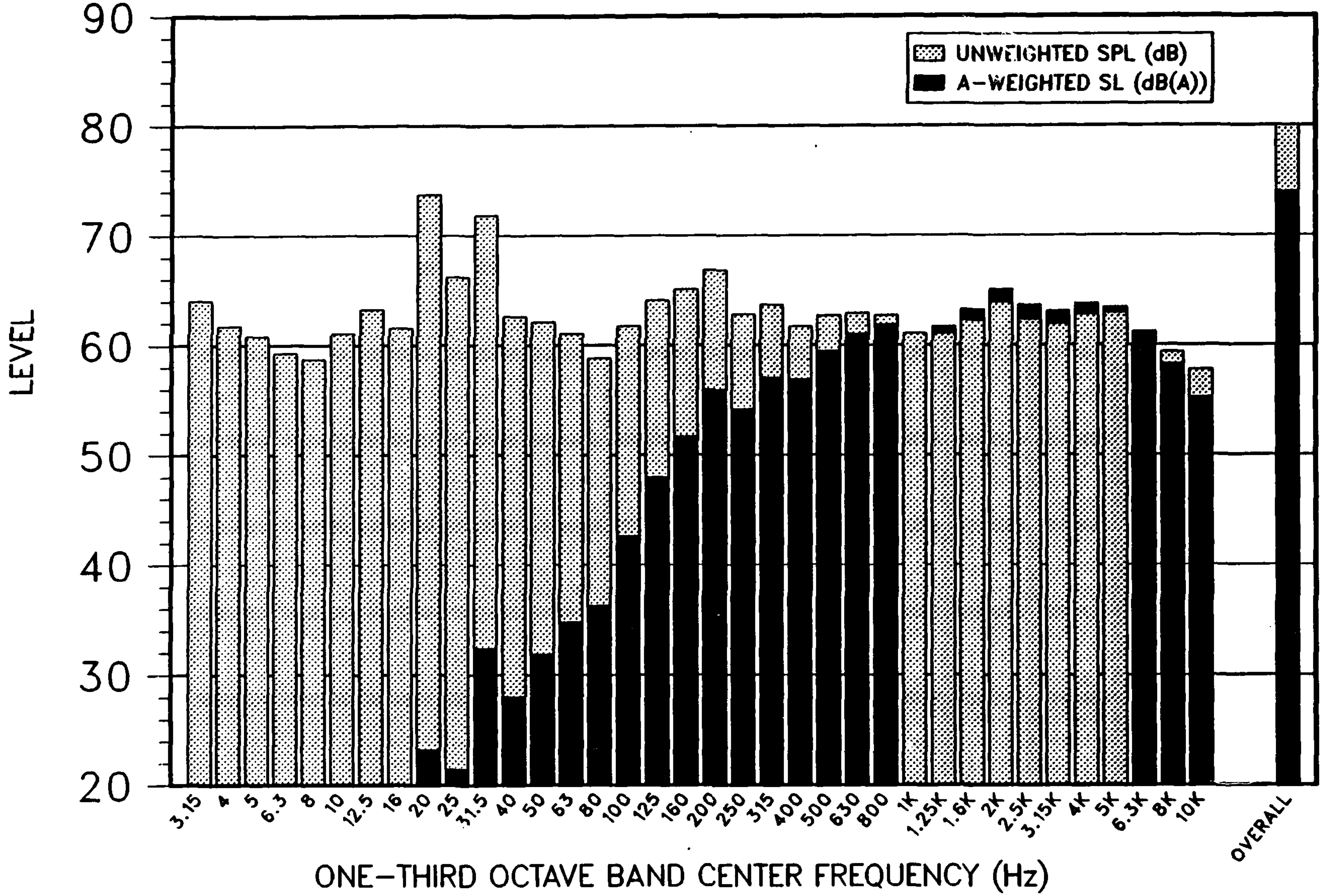


Table 19: Hill AFB Depot Armament Repair Building.
Measurement Location: Section 3 of Main Bay - Ejectors/ Launchers/Bomb Rack Repair.
Measurement Conditions: Normal Operations and Spray Paint Booth Turned On.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	54.5	0.0	0.0			
4	57.2	0.0	0.0	61.9	0.0	0.0
5	58.6	0.0	0.0			
6.3	56.0	0.0	0.0			
8	56.6	0.0	0.0	62.9	4.8	46.2
10	60.5	0.0	46.2			
12.5	63.4	0.0	52.1			
16	65.7	9.0	57.3	71.6	19.3	64.4
20	69.3	18.8	63.1			
25	67.8	23.1	63.4			
31.5	67.4	28.0	64.4	71.8	33.3	68.6
40	65.7	31.1	63.7			
50	65.7	35.5	64.4			
63	63.3	37.0	62.5	70.4	45.7	69.6
80	67.1	44.6	66.6			
100	67.5	48.4	67.2			
125	70.8	54.7	70.6	74.1	58.7	73.9
160	69.1	55.7	69.0			
200	69.8	58.9	69.8			
250	65.1	56.5	65.1	71.6	62.1	71.6
315	62.8	56.2	62.8			
400	62.3	57.5	62.3			
500	63.1	59.9	63.1	67.7	64.6	67.7
630	63.2	61.3	63.2			
800	62.6	61.8	62.6			
1000	61.8	61.8	61.8	66.4	66.2	66.4
1250	60.1	60.7	60.1			
1600	59.1	60.1	59.0			
2000	57.3	58.5	57.1	62.5	63.6	62.3
2500	56.2	57.5	55.9			
3150	53.9	55.1	53.4			
4000	50.6	51.6	49.8	56.4	57.5	55.7
5000	48.8	49.3	47.5			
6300	46.0	45.9	44.1			
8000	43.1	42.0	40.1	48.7	48.0	46.1
10000	41.1	38.7	36.7			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 79.9 dB　　OASLA = 70.9 dB(A)

OASLC = 78.5 dB(C)　　C-A VALUE = +7.6

Figure 19: Hill AFB Depot Armament Repair Building.
Measurement Location: Section 3 of Main Bay – Bomb Rack Repair.
Measurement Conditions: Normal Operations w/Spray Paint Booth On.

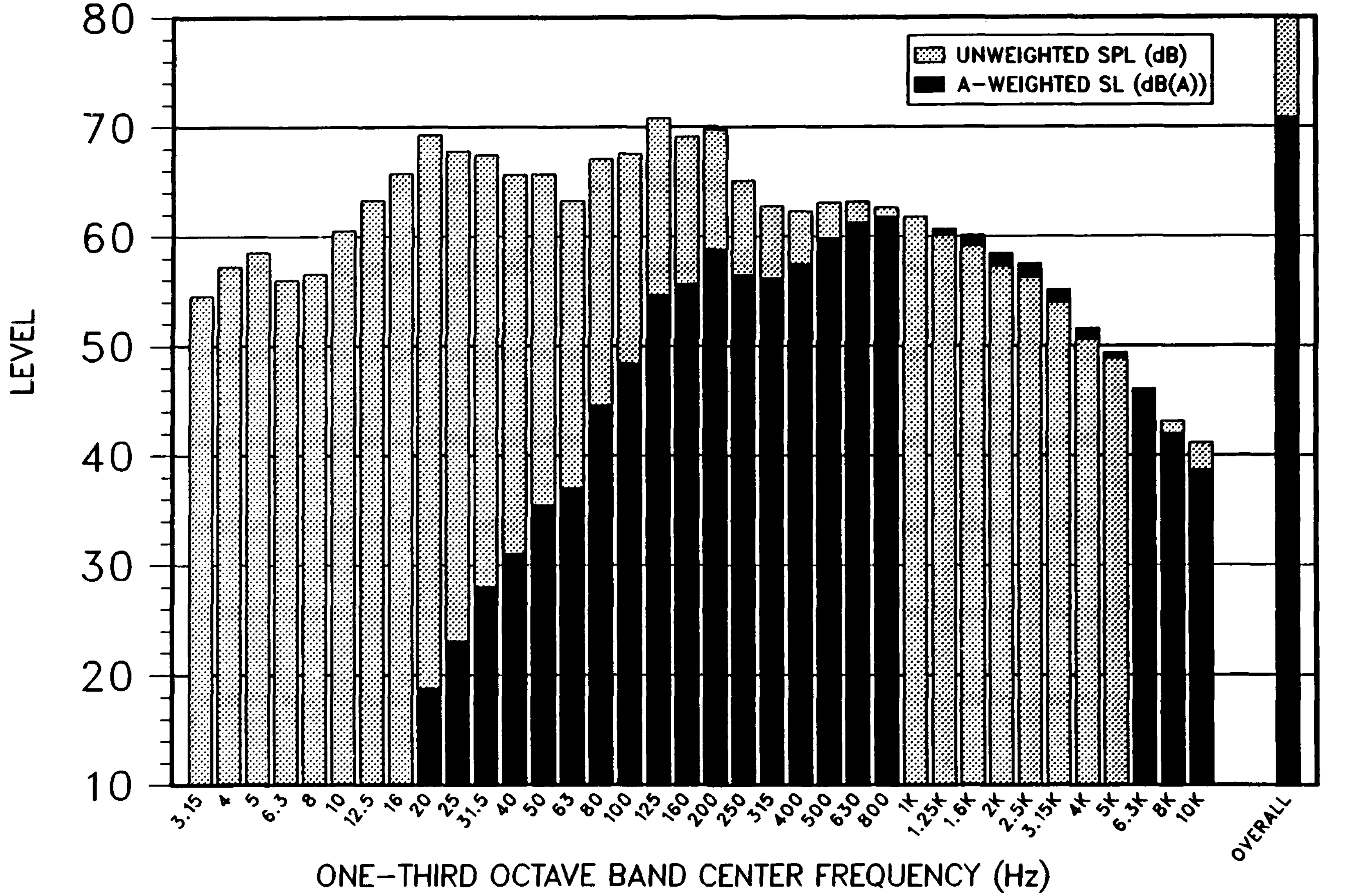


Table 20: Hill AFB Depot Armament Repair Building.
Measurement Location: Section 4 of Main Bay - Pylon Repair Area.
Measurement Conditions: Normal Operations and Spray Paint Booth Turned On.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	58.0	0.0	0.0			
4	57.0	0.0	0.0	62.2	0.0	0.0
5	57.3	0.0	0.0			
6.3	54.4	0.0	0.0			
8	55.2	0.0	0.0	65.2	4.8	50.0
10	64.3	0.0	50.0			
12.5	63.9	.5	52.7			
16	65.7	9.0	57.2	70.0	16.3	62.1
20	65.8	15.3	59.6			
25	68.3	23.6	63.9			
31.5	73.0	33.6	70.0	74.9	36.0	71.8
40	66.3	31.7	64.3			
50	65.2	35.0	63.9			
63	62.3	36.1	61.5	72.5	48.9	71.8
80	71.0	48.5	70.5			
100	72.1	53.0	71.8			
125	68.1	52.0	67.9	76.0	60.5	75.8
160	72.2	58.8	72.1			
200	72.3	61.4	72.3			
250	68.0	59.4	68.0	74.3	65.0	74.3
315	66.1	59.5	66.1			
400	63.5	58.7	63.5			
500	65.5	62.3	65.5	69.2	66.1	69.2
630	64.1	62.2	64.1			
800	64.2	63.4	64.2			
1000	62.6	62.6	62.6	67.7	67.5	67.7
1250	61.5	62.1	61.5			
1600	60.4	61.4	60.3			
2000	58.6	59.8	58.4	64.0	65.1	63.8
2500	58.2	59.4	57.9			
3150	56.1	57.4	55.6			
4000	53.9	54.9	53.1	59.2	60.2	58.5
5000	52.5	53.0	51.2			
6300	49.4	49.3	47.4			
8000	46.8	45.7	43.8	52.1	51.4	49.5
10000	44.0	41.5	39.6			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 81.7 dB OASLA = 72.7 dB(A)

OASLC = 80.6 dB(C) C-A VALUE = +7.9

Figure 20: Hill AFB Depot Armament Repair Building.
Measurement Location: Section 4 of Main Bay – Pylon Repair Area.
Measurement Conditions: Normal Operations w/Spray Paint Booth On.

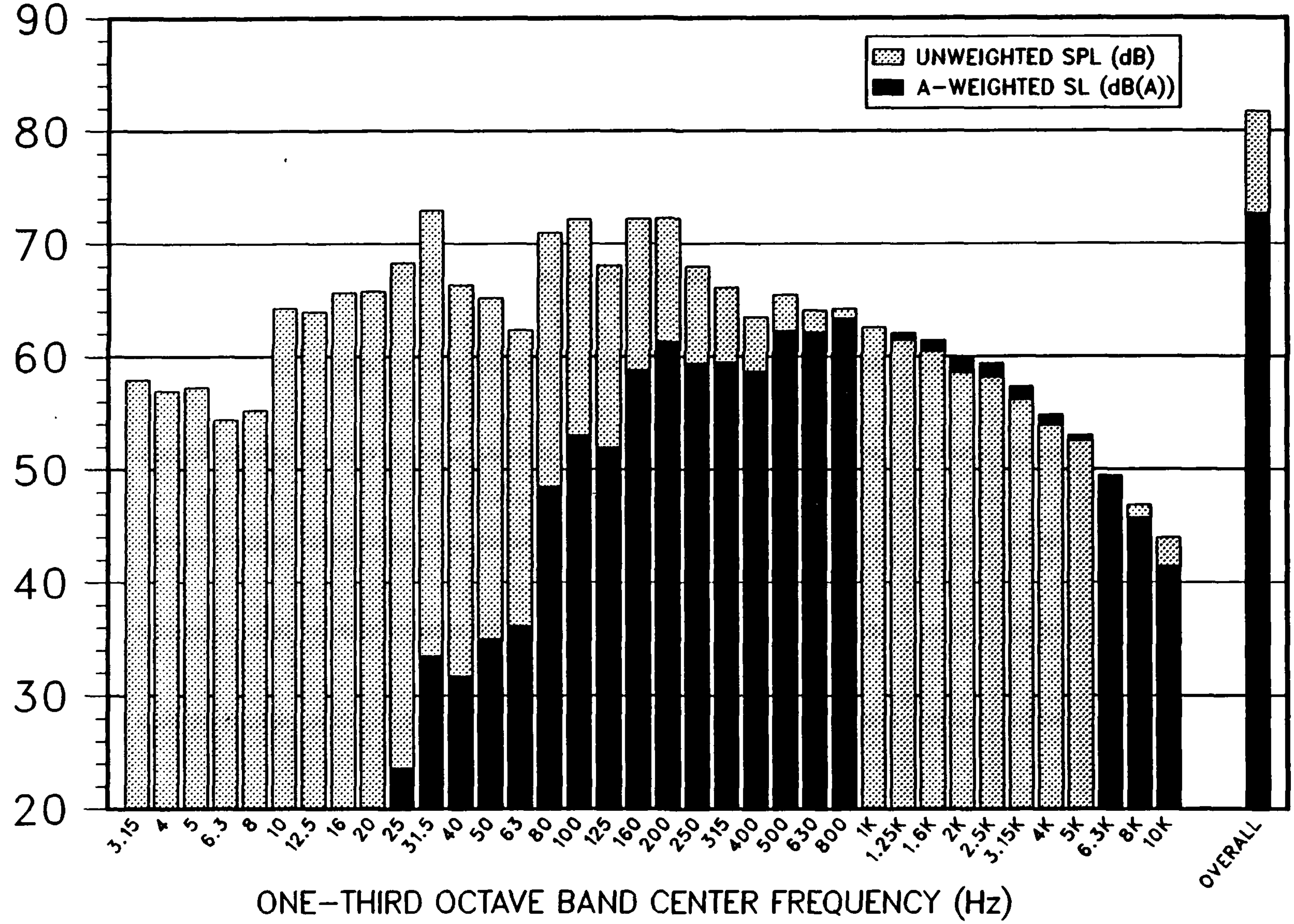


Table 21: Hill AFB Depot Armament Repair Building.
Measurement Location: ALCM Repair Area.
Measurement Conditions: Normal Operations and Radio On.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	51.0	0.0	0.0			
4	58.8	0.0	0.0	61.3	0.0	0.0
5	56.5	0.0	0.0			
6.3	49.7	0.0	0.0			
8	56.9	0.0	0.0	59.9	4.8	41.8
10	56.1	0.0	41.8			
12.5	54.5	0.0	43.3			
16	54.3	0.0	45.8	61.6	10.0	54.4
20	59.5	9.0	53.3			
25	56.8	12.1	52.4			
31.5	55.5	16.1	52.5	60.6	22.1	57.4
40	54.8	20.2	52.8			
50	52.9	22.7	51.6			
63	52.6	26.5	51.9	56.9	30.9	56.0
80	50.4	27.9	49.9			
100	53.0	33.9	52.7			
125	55.4	39.3	55.2	59.2	43.8	59.0
160	54.6	41.2	54.5			
200	54.8	43.9	54.8			
250	50.6	42.0	50.6	58.0	49.4	58.0
315	53.3	46.7	53.3			
400	50.1	45.3	50.1			
500	49.1	45.9	49.1	54.1	50.7	54.1
630	48.5	46.6	48.5			
800	52.7	51.9	52.7			
1000	48.2	48.2	48.2	54.9	54.6	54.9
1250	47.5	48.1	47.5			
1600	51.0	52.0	50.9			
2000	49.9	51.1	49.7	54.4	55.5	54.2
2500	46.7	48.0	46.4			
3150	46.5	47.7	46.0			
4000	37.5	38.5	36.7	47.4	48.5	46.8
5000	36.1	36.6	34.8			
6300	35.5	35.4	33.5			
8000	35.7	34.6	32.8	40.4	39.3	37.4
10000	35.6	33.2	31.3			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 68.9 dB OASLA = 59.8 dB(A)

OASLC = 65.5 dB(C) C-A VALUE = +5.7

Figure 21: Hill AFB Depot Armament Repair Building.
Measurement Location: ALCM Repair Area.
Measurement Conditions: Normal Operations and Radio On.

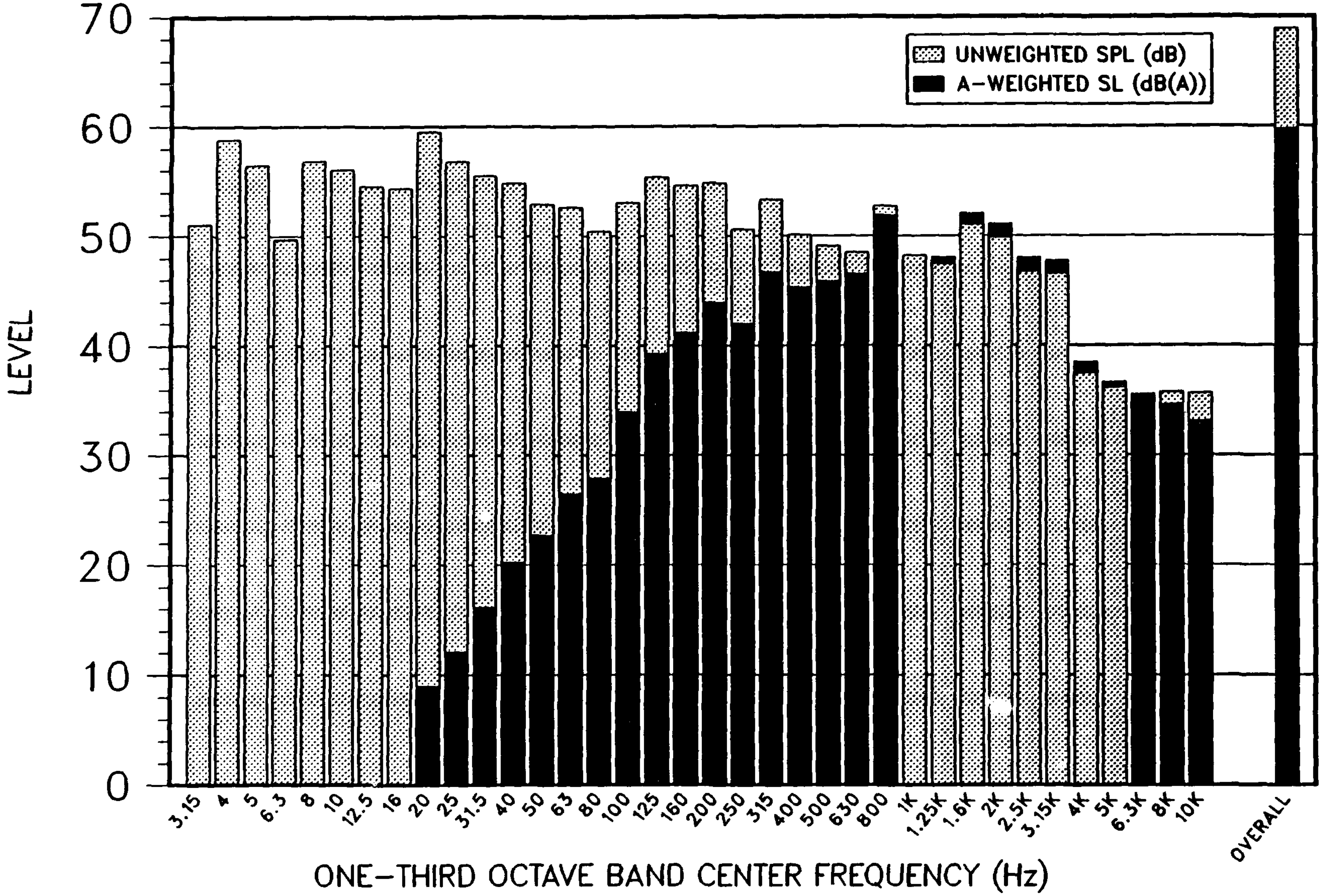


Table 22: Hill AFB Depot Armament Repair Building.
Measurement Location: Sheet Metal Repair.
Measurement Conditions: Background Noise Under Normal Operations.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	59.3	0.0	0.0			
4	58.8	0.0	0.0	64.9	0.0	0.0
5	61.8	0.0	0.0			
6.3	61.7	0.0	0.0			
8	59.3	0.0	0.0	64.9	4.8	44.5
10	58.8	0.0	44.5			
12.5	58.3	0.0	47.0			
16	61.1	4.4	52.6	73.9	23.1	67.5
20	73.5	23.0	67.3			
25	72.1	27.4	67.7			
31.5	62.5	23.1	59.6	72.6	29.1	68.4
40	52.1	17.5	50.1			
50	55.9	25.7	54.6			
63	55.7	29.6	54.9	61.5	36.9	60.7
80	58.1	35.6	57.6			
100	62.0	42.9	61.9			
125	65.6	49.5	65.4	69.4	54.3	69.2
160	65.4	52.0	65.3			
200	63.9	53.0	63.9			
250	60.0	51.4	60.0	67.0	58.3	67.0
315	61.9	55.2	61.9			
400	62.8	58.0	62.8			
500	63.9	60.7	63.9	68.0	64.8	68.0
630	62.8	60.9	62.8			
800	59.3	58.5	59.3			
1000	57.0	57.0	57.0	62.9	62.7	62.8
1250	57.5	58.1	57.5			
1600	57.2	58.2	57.1			
2000	57.0	58.2	56.8	61.4	62.5	61.2
2500	55.3	56.6	55.0			
3150	53.6	54.8	53.1			
4000	48.3	49.3	47.5	55.4	56.4	54.7
5000	46.5	47.0	45.2			
6300	44.8	44.7	42.8			
8000	44.1	42.9	41.0	48.8	47.8	45.9
10000	43.0	40.5	38.7			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 78.7 dB   OASLA = 69.1 dB(A)
OASLC = 75.7 dB(C)   C-A VALUE = +6.6

Figure 22: Hill AFB Depot Armament Repair Building.
Measurement Location: Sheet Metal Repair Area.
Measurement Conditions: Background Noise Under Normal Operations.

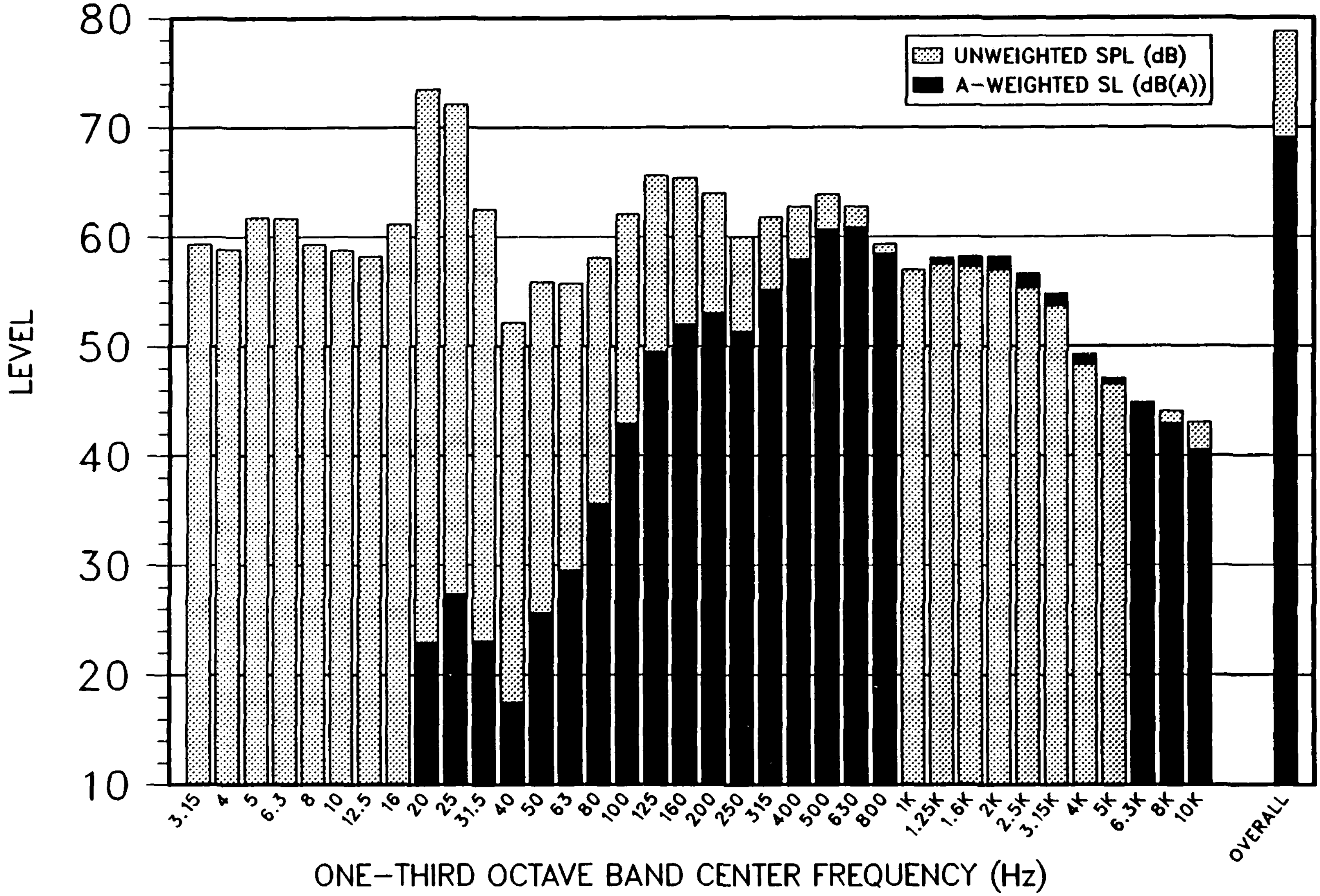


Table 23: Hill AFB Depot Armament Repair Building.
Measurement Location: Sheet Metal Repair at Worker's Ear Position.
Measurement Conditions: Normal Operations with Riveting.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	76.8	0.0	0.0			
4	78.7	0.0	0.0	81.9	0.0	0.0
5	75.3	0.0	0.0			
6.3	75.0	0.0	0.0			
8	74.6	0.0	0.0	79.4	6.5	60.0
10	74.3	3.8	60.0			
12.5	74.3	10.9	63.1			
16	72.5	15.8	64.0	79.3	26.1	71.5
20	76.0	25.5	69.8			
25	75.2	30.5	70.8			
31.5	72.1	32.7	69.1	77.8	38.3	74.3
40	70.5	35.9	68.5			
50	69.8	39.6	68.5			
63	68.7	42.5	67.9	73.4	47.4	72.5
80	66.9	44.4	66.4			
100	67.9	48.8	67.6			
125	71.2	55.1	71.0	80.1	66.2	80.0
160	79.2	65.8	79.1			
200	74.9	64.0	74.9			
250	79.3	70.7	79.3	83.4	75.7	83.4
315	80.2	73.6	80.2			
400	77.3	72.5	77.3			
500	77.7	74.5	77.7	81.8	78.5	81.8
630	75.7	73.8	75.7			
800	76.7	75.9	76.7			
1000	81.5	81.5	81.5	88.9	89.4	88.9
1250	87.8	88.4	87.8			
1600	82.4	83.4	82.3			
2000	81.1	82.3	80.9	86.1	87.3	86.0
2500	80.5	81.8	80.2			
3150	85.5	86.7	85.0			
4000	81.8	82.8	80.9	88.3	89.3	87.5
5000	82.4	82.9	81.1			
6300	85.2	85.1	83.2			
8000	82.4	81.3	79.4	89.1	88.0	86.1
10000	84.9	82.4	80.5			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 95.5 dB OASLA = 94.8 dB(A)
OASLC = 94.3 dB(C) C-A VALUE = -.5

Figure 23: Hill AFB Depot Armament Repair Building.
Measurement Location: Sheet Metal Repair at Worker's Ear Position.
Measurement Conditions: Normal Operations with Riveting Noise.

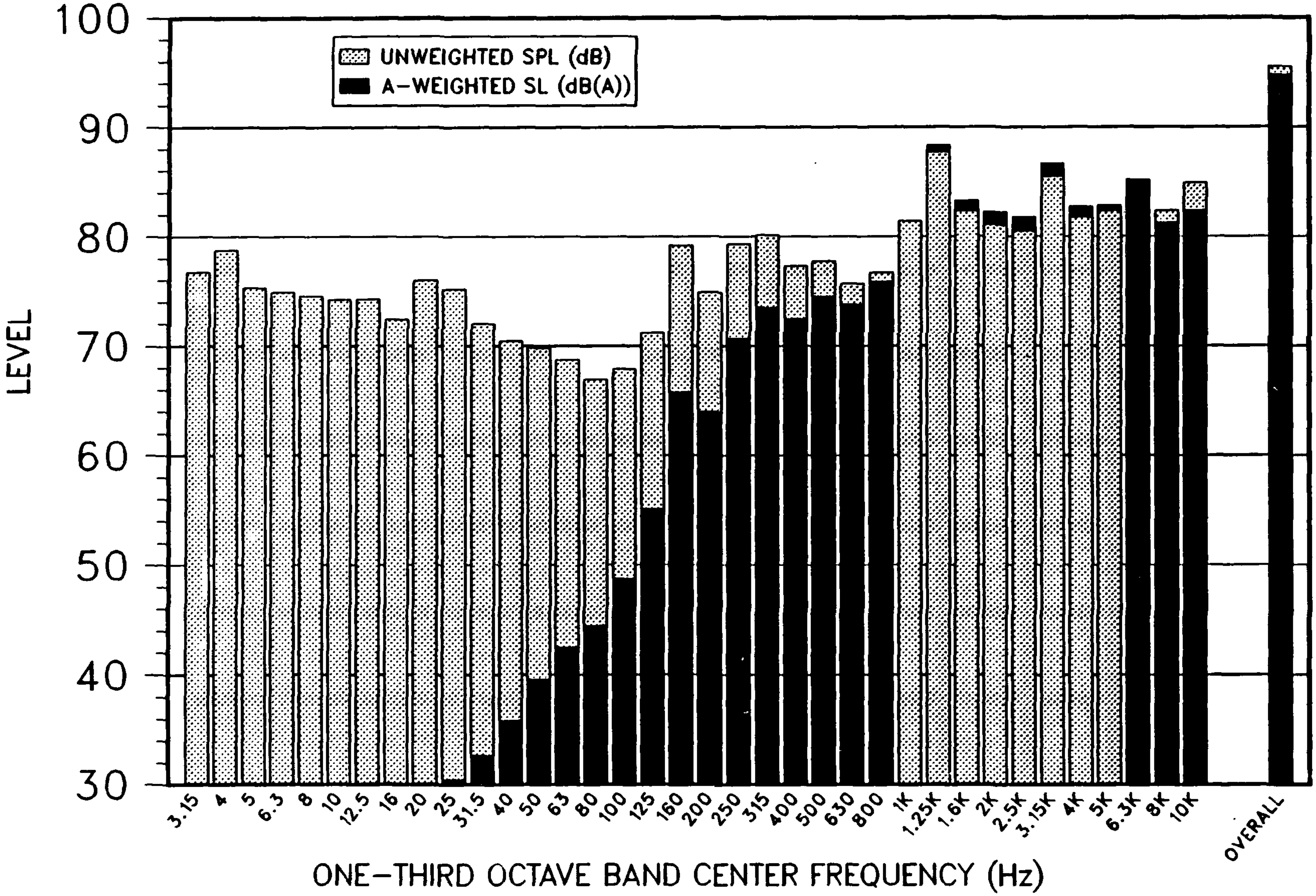


Table 24: Hill AFB Depot Armament Repair Building.
Measurement Location: Sheet Metal Repair at Mid Room Location.
Measurement Conditions: Normal Operations with Riveting.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	57.7	0.0	0.0			
4	57.4	0.0	0.0	62.0	0.0	0.0
5	56.7	0.0	0.0			
6.3	58.1	0.0	0.0			
8	58.6	0.0	0.0	62.3	4.8	41.0
10	55.2	0.0	41.0			
12.5	60.1	0.0	48.9			
16	61.6	4.9	53.1	66.4	13.3	58.7
20	62.9	12.4	56.7			
25	62.5	17.8	58.1			
31.5	61.5	22.2	58.6	65.3	24.7	61.7
40	53.0	18.4	51.0			
50	54.9	24.7	53.6			
63	55.4	29.2	54.6	60.8	36.1	60.0
80	57.3	34.8	56.8			
100	61.4	42.3	61.1			
125	63.6	47.5	63.4	67.2	51.7	67.0
160	62.2	48.7	62.0			
200	64.8	53.9	64.8			
250	65.9	57.3	65.9	71.3	63.4	71.3
315	68.1	61.5	68.1			
400	67.5	62.7	67.5			
500	68.8	65.6	68.8	72.7	69.5	72.7
630	67.3	65.4	67.3			
800	67.9	67.1	67.9			
1000	70.3	70.3	70.3	74.7	74.8	74.7
1250	71.0	71.6	71.0			
1600	68.7	69.7	68.6			
2000	68.3	69.6	68.1	74.1	75.2	73.8
2500	70.5	71.8	70.2			
3150	78.4	79.6	77.9			
4000	71.1	72.1	70.3	79.8	80.8	79.1
5000	71.2	71.7	69.9			
6300	80.3	80.2	78.3			
8000	69.1	68.0	66.1	80.9	80.6	78.7
10000	68.1	65.6	63.7			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 85.1 dB   OASLA = 84.9 dB(A)
OASLC = 84.0 dB(C)   C-A VALUE = -1.0

Figure 24: Hill AFB Depot Armament Repair Building.
Measurement Location: Sheet Metal Repair at Mid Room Location.
Measurement Conditions: Normal Operations with Riveting Noise.

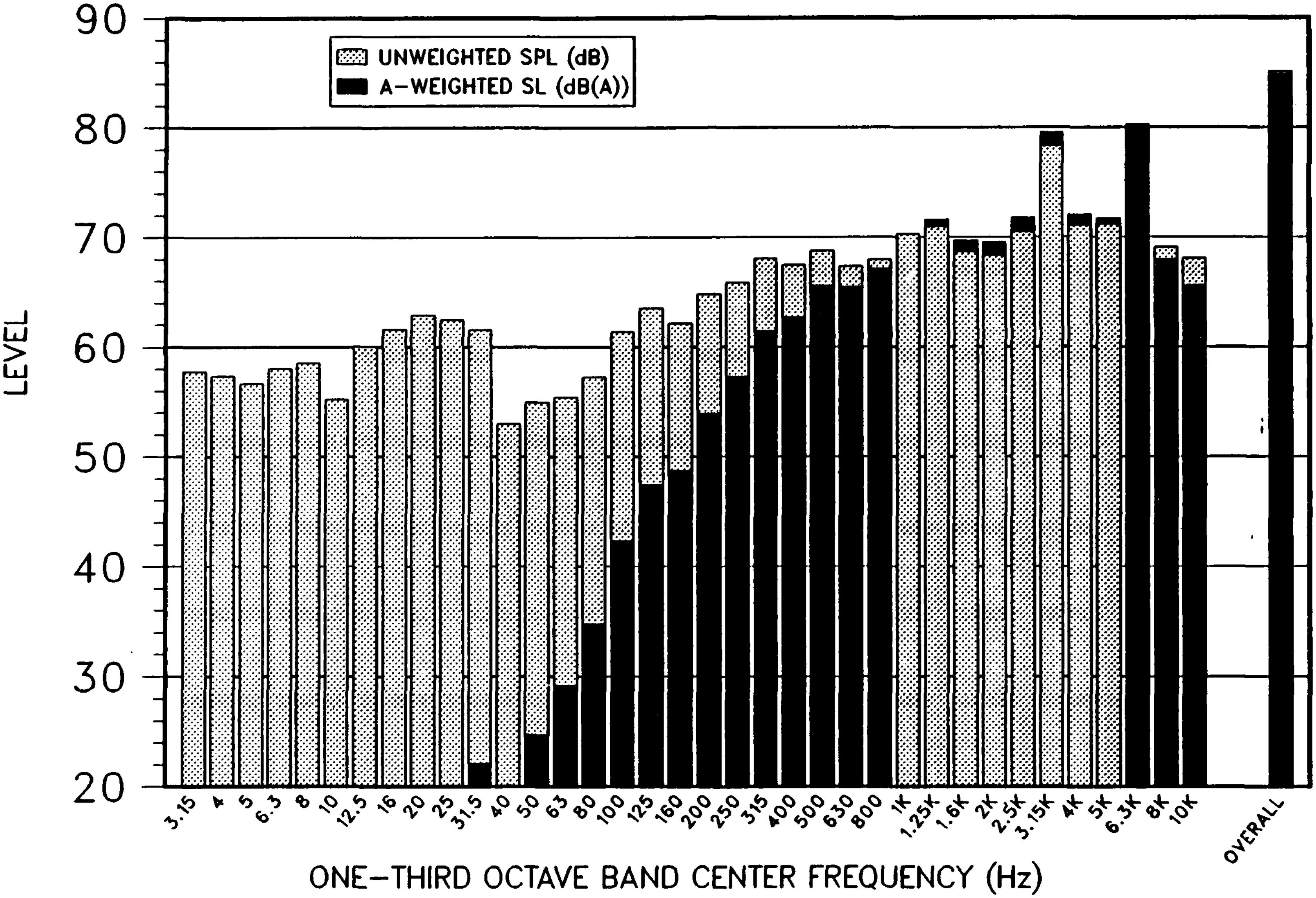


Table 25: Hill AFB Depot Armament Repair Building.
Measurement Location: Sheet Metal Repair - North End of Room.
Measurement Conditions: Normal Operations with Riveting.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	72.8	0.0	0.0			
4	62.2	0.0	0.0	73.5	0.0	0.0
5	62.6	0.0	0.0			
6.3	73.3	0.0	0.0			
8	62.8	0.0	0.0	73.9	4.8	45.6
10	59.9	0.0	45.6			
12.5	55.7	0.0	44.6			
16	62.1	5.4	53.6	67.1	15.1	60.1
20	65.0	14.5	58.8			
25	65.9	21.2	61.5			
31.5	61.2	21.7	58.2	67.5	26.2	63.6
40	55.8	21.2	53.8			
50	50.0	19.8	48.7			
63	53.3	27.1	52.5	56.6	31.4	55.8
80	51.4	28.9	50.9			
100	52.4	33.3	52.1			
125	57.1	41.0	56.9	61.1	46.2	60.9
160	57.7	44.3	57.6			
200	60.4	49.5	60.4			
250	63.0	54.4	63.0	67.6	59.8	67.6
315	64.3	57.7	64.3			
400	62.2	57.4	62.2			
500	65.9	62.7	65.9	71.4	68.9	71.4
630	69.2	67.3	69.2			
800	70.5	69.7	70.5			
1000	77.4	77.4	77.4	79.4	79.5	79.4
1250	73.4	74.0	73.4			
1600	69.8	70.8	69.7			
2000	68.4	69.6	68.2	73.7	74.9	73.6
2500	68.6	69.9	68.3			
3150	65.4	66.6	64.9			
4000	65.7	66.7	64.9	70.2	71.2	69.4
5000	65.2	65.7	64.0			
6300	62.6	62.5	60.6			
8000	60.4	59.3	57.5	65.3	64.6	62.7
10000	56.6	54.0	52.1			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 83.1 dB OASLA = 81.6 dB(A)
OASLC = 81.6 dB(C) C-A VALUE = +0.0

Figure 25: Hill AFB Depot Armament Repair Building.
Measurement Location: Sheet Metal Repair – North End of Room.
Measurement Conditions: Normal Operations with Riveting Noise.

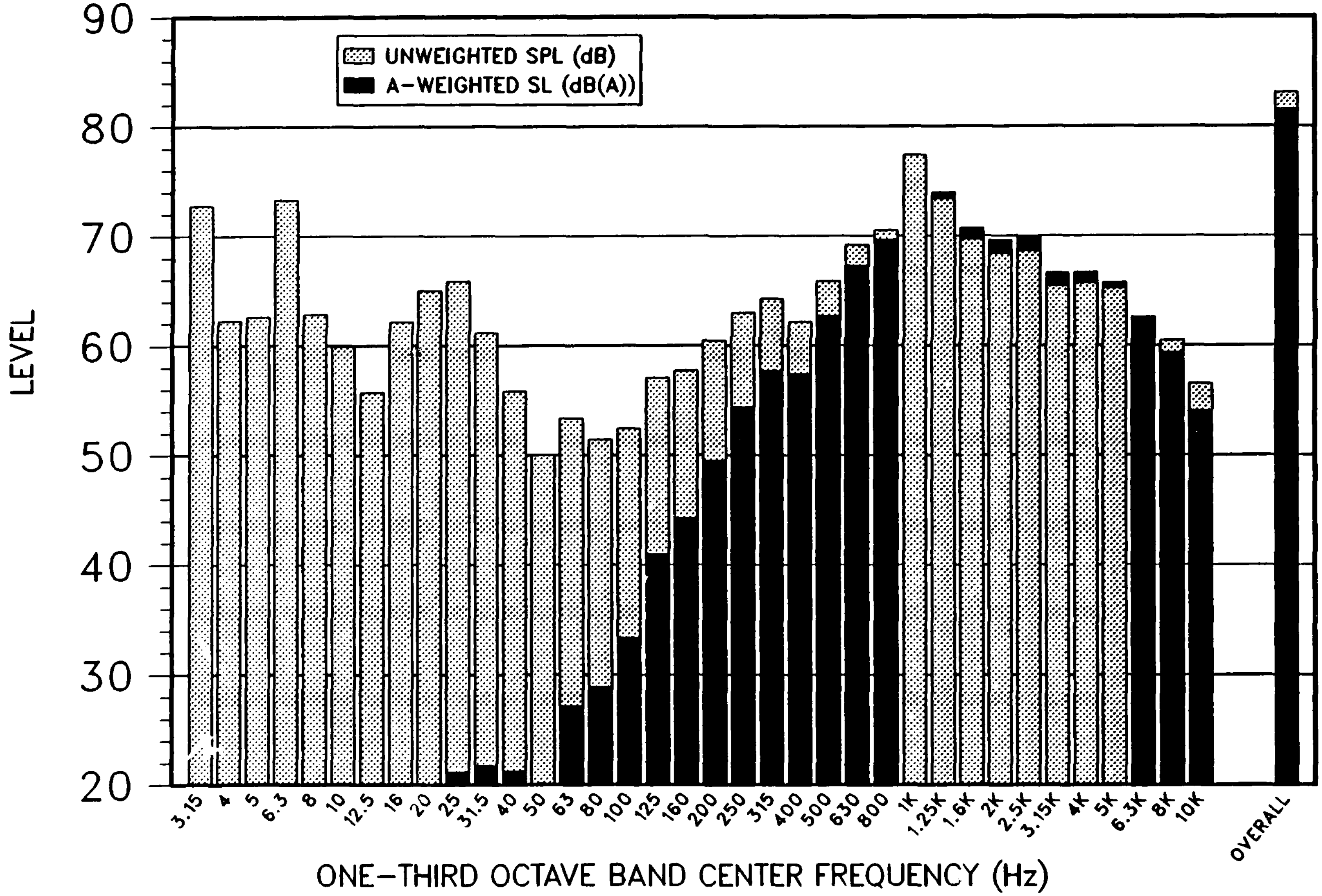


Table 26: Hill AFB Depot Armament Repair Building.
Measurement Location: Sheet Metal Repair - North End of Room.
Measurement Conditions: Background Noise Under Normal Operations.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	58.2	0.0	0.0			
4	57.4	0.0	0.0	62.0	0.0	0.0
5	55.5	0.0	0.0			
6.3	55.1	0.0	0.0			
8	53.4	0.0	0.0	58.2	4.8	36.5
10	50.8	0.0	36.5			
12.5	50.9	0.0	39.7			
16	51.7	0.0	43.2	59.0	8.2	51.9
20	57.2	6.7	51.0			
25	55.0	10.3	50.6			
31.5	58.1	18.6	55.0	60.1	20.2	56.7
40	47.7	13.1	45.7			
50	49.0	18.8	47.8			
63	54.4	28.2	53.6	57.3	32.4	56.5
80	52.6	30.1	52.1			
100	51.4	32.3	51.1			
125	55.1	39.0	54.8	59.5	44.7	59.4
160	56.5	43.0	56.4			
200	61.2	50.3	61.2			
250	62.9	54.3	62.9	67.3	59.3	67.3
315	63.3	56.7	63.3			
400	63.8	59.0	63.8			
500	63.8	60.6	63.8	68.8	65.8	68.8
630	64.5	62.6	64.5			
800	62.3	61.5	62.3			
1000	60.9	60.9	60.9	65.7	65.5	65.7
1250	59.1	59.7	59.1			
1600	59.0	60.0	58.9			
2000	57.3	58.5	57.1	62.4	63.5	62.2
2500	56.0	57.3	55.7			
3150	53.3	54.6	52.8			
4000	50.2	51.2	49.4	56.1	57.1	55.4
5000	49.5	50.0	48.2			
6300	47.3	47.2	45.3			
8000	44.6	43.5	41.6	50.1	49.4	47.5
10000	43.1	40.6	38.7			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 73.9 dB   OASLA = 70.4 dB(A)
OASLC = 73.2 dB(C)   C-A VALUE = +2.7

Figure 26: Hill AFB Depot Armament Repair Building.
Measurement Location: Sheet Metal Repair – North End of Room.
Measurement Conditions: Background Noise Under Normal Operations.

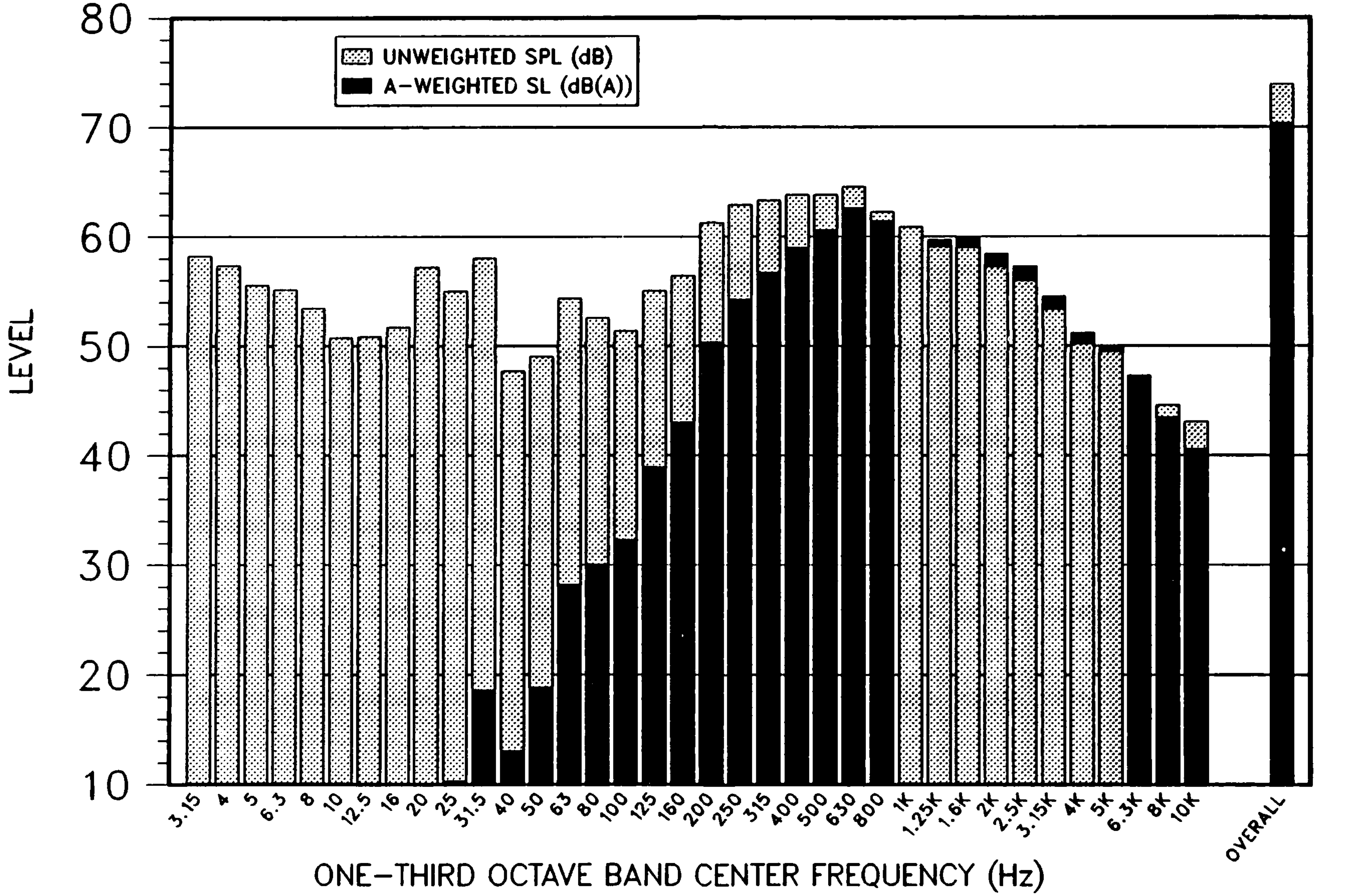


Table 27: Hill AFB Depot Armament Repair Building.
Measurement Location: Main Bay - Steam Cleaning Area.
Measurement Conditions: Steam Cleaning Start-Up.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	82.8	0.0	0.0			
4	84.9	0.0	0.0	89.0	0.0	0.0
5	84.8	0.0	0.0			
6.3	85.8	0.0	0.0			
8	84.8	0.0	0.0	90.0	14.8	70.7
10	85.0	14.6	70.7			
12.5	85.3	21.9	74.0			
16	85.9	29.2	77.4	90.5	36.6	82.5
20	86.1	35.6	79.9			
25	85.3	40.6	80.9			
31.5	83.6	44.2	80.6	88.8	50.1	85.5
40	82.7	48.1	80.7			
50	82.4	52.1	81.0			
63	81.4	55.2	80.6	86.2	60.4	85.3
80	80.2	57.8	79.7			
100	80.2	61.1	79.9			
125	78.8	62.7	78.6	83.7	67.6	83.5
160	77.6	64.2	77.5			
200	77.0	66.1	77.0			
250	74.3	65.7	74.3	79.7	70.5	79.7
315	72.1	65.5	72.1			
400	69.8	65.0	69.8			
500	68.7	65.5	68.7	74.0	70.8	74.0
630	69.2	67.3	69.2			
800	69.8	69.0	69.8			
1000	71.3	71.3	71.3	76.3	76.5	76.3
1250	73.0	73.6	73.0			
1600	75.0	76.0	74.9			
2000	75.8	77.0	75.5	80.4	81.6	80.2
2500	76.1	77.4	75.8			
3150	76.5	77.7	76.0			
4000	76.6	77.6	75.8	81.5	82.4	80.6
5000	77.1	77.6	75.8			
6300	75.5	75.4	73.5			
8000	73.5	72.4	70.5	78.6	77.8	75.9
10000	71.4	68.9	67.0			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 96.8 dB   OASLA = 86.6 dB(A)

OASLC = 91.8 dB(C)   C-A VALUE = +5.3

Figure 27: Hill AFB Depot Armament Repair Building.
Measurement Location: Main Bay – Steam Cleaning Area.
Measurement Conditions: Steam Cleaning Start–Up.

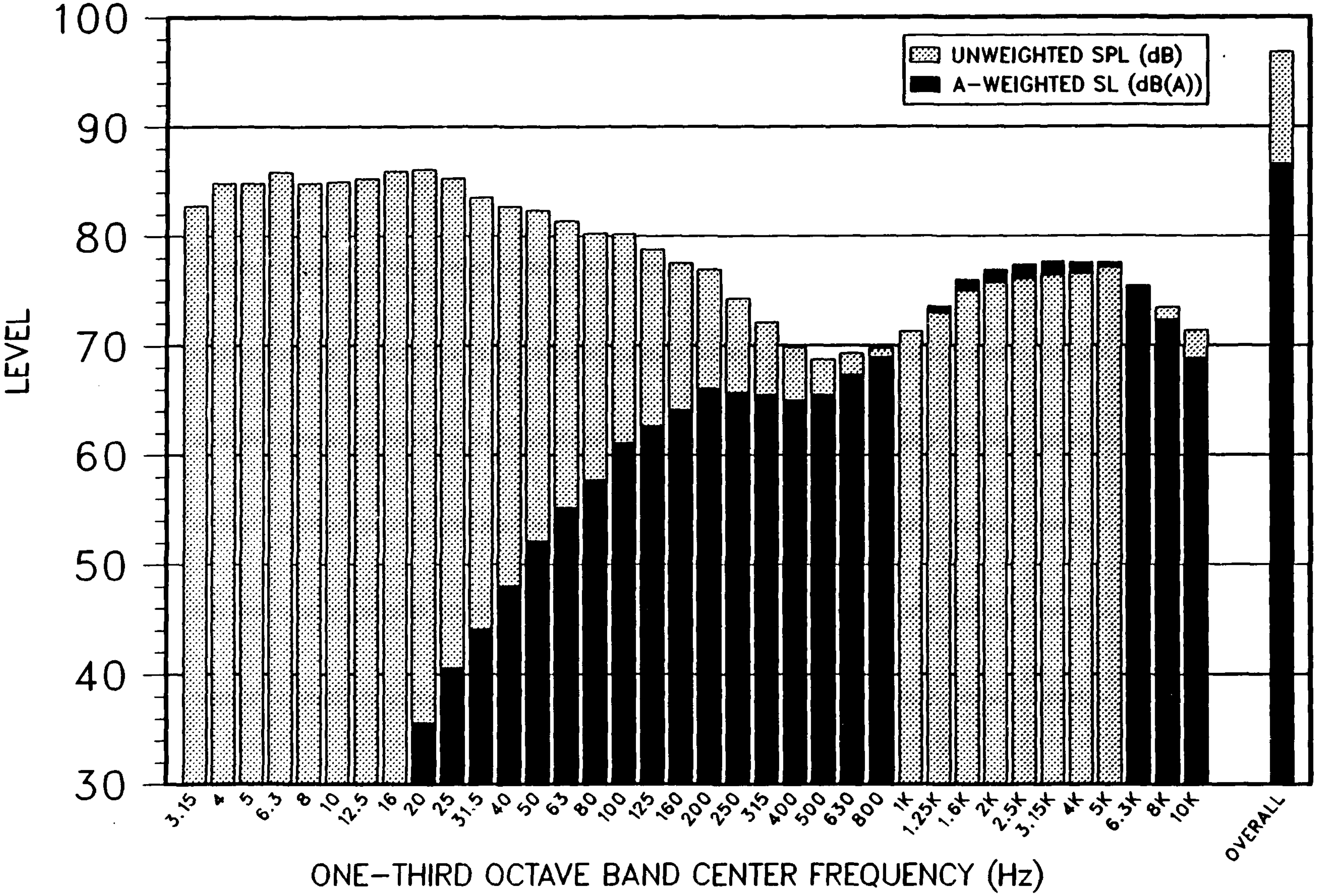


Table 28: Hill AFB Depot Armament Repair Building.
Measurement Location: Main Bay - Outside of Steam Cleaner Curtain.
Measurement Conditions: Steam Cleaning Start-Up.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	86.8	0.0	0.0			
4	85.3	0.0	0.0	91.3	0.0	0.0
5	87.3	0.0	0.0			
6.3	85.8	0.0	0.0			
8	86.0	0.0	0.0	90.8	16.1	72.0
10	86.3	15.8	72.0			
12.5	87.4	24.0	76.2			
16	87.0	30.3	78.5	91.5	36.7	83.1
20	85.8	35.3	79.6			
25	85.6	40.9	81.2			
31.5	84.0	44.6	80.9	88.9	50.0	85.6
40	82.3	47.6	80.2			
50	81.2	51.0	79.9			
63	79.9	53.7	79.1	84.9	59.1	84.0
80	79.1	56.6	78.6			
100	78.5	59.4	78.2			
125	76.9	60.8	76.7	82.0	65.9	81.8
160	75.9	62.5	75.8			
200	74.4	63.5	74.4			
250	71.6	63.0	71.6	77.1	68.0	77.1
315	69.8	63.1	69.8			
400	68.4	63.6	68.4			
500	68.0	64.8	68.0	72.6	69.3	72.6
630	67.1	65.2	67.1			
800	65.9	65.1	65.9			
1000	64.6	64.6	64.6	70.1	70.0	70.1
1250	65.5	66.0	65.5			
1600	68.9	69.9	68.8			
2000	69.6	70.8	69.4	73.4	74.5	73.2
2500	67.0	68.3	66.7			
3150	65.2	66.4	64.7			
4000	65.1	66.1	64.3	69.6	70.5	68.8
5000	64.2	64.7	62.9			
6300	62.5	62.4	60.5			
8000	60.1	59.0	57.1	65.4	64.6	62.7
10000	58.3	55.8	53.9			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 97.3 dB   OASLA = 78.6 dB(A)
OASLC = 90.4 dB(C)   C-A VALUE = +11.8

Figure 28: Hill AFB Depot Armament Repair Building.
Measurement Location: Main Bay – Outside of Steam Cleaner Curtain.
Measurement Conditions: Steam Cleaning Start–Up.

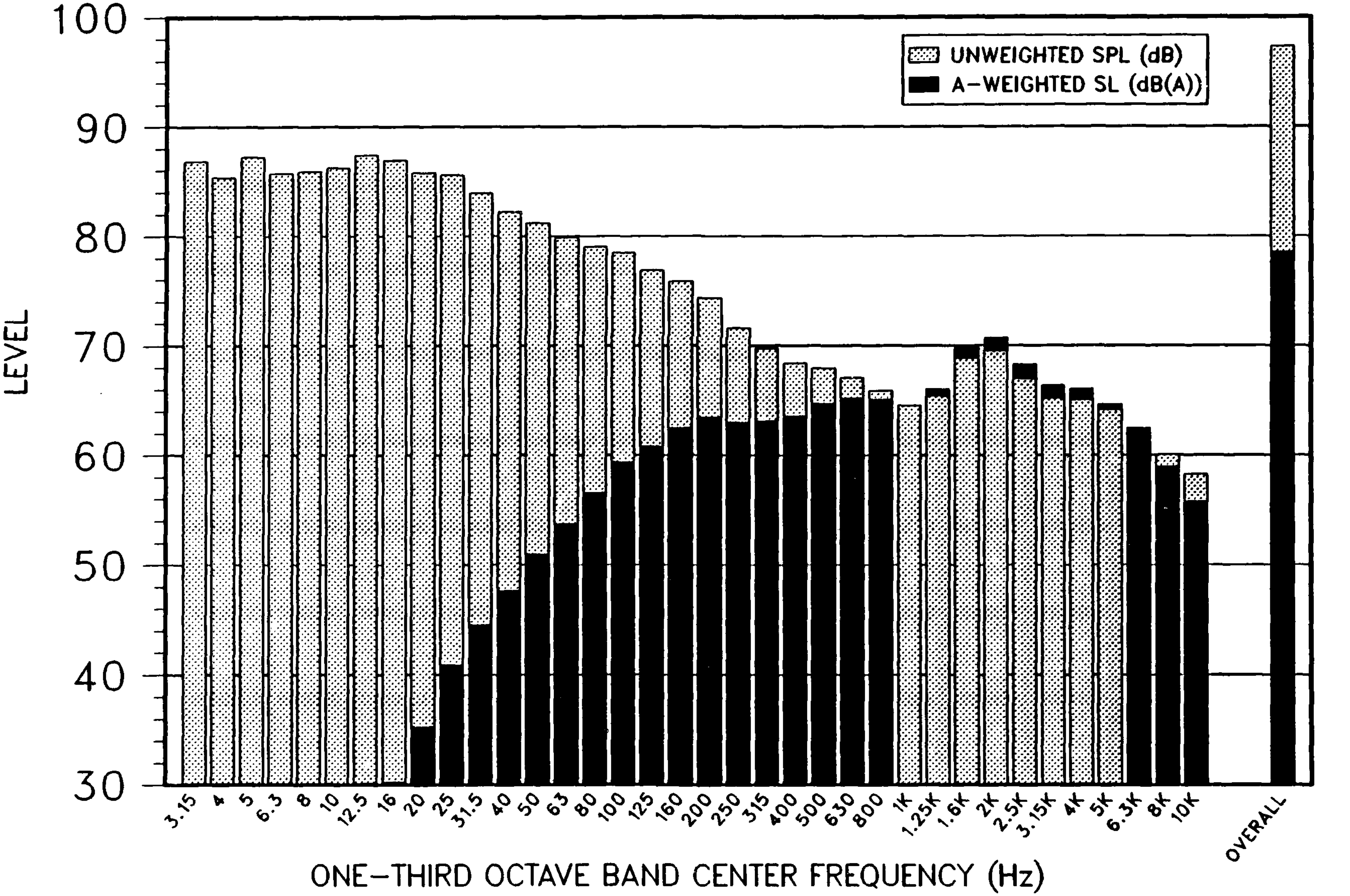


Table 29: Hill AFB Depot Armament Repair Building.
Measurement Location: Main Bay - Outside of Steam Cleaner Curtain.
Measurement Conditions: Steam Cleaning Normal Operation.

FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	89.3	0.0	0.0			
4	89.5	0.0	0.0	94.3	0.0	0.0
5	89.7	0.0	0.0			
6.3	89.5	0.0	0.0			
8	89.4	0.0	0.0	94.2	19.3	75.3
10	89.6	19.2	75.3			
12.5	89.4	26.0	78.2			
16	88.8	32.0	80.2	93.4	38.6	85.0
20	87.7	37.2	81.5			
25	88.0	43.3	83.6			
31.5	87.0	47.6	84.0	92.0	53.7	88.8
40	86.6	52.0	84.6			
50	85.8	55.6	84.5			
63	84.5	58.3	83.7	89.4	63.4	88.4
80	83.1	60.6	82.6			
100	83.1	64.0	82.8			
125	81.3	65.2	81.1	86.4	70.0	86.1
160	79.7	66.3	79.6			
200	78.4	67.5	78.4			
250	75.9	67.3	75.9	81.1	72.0	81.1
315	73.4	66.8	73.4			
400	70.4	65.6	70.4			
500	68.0	64.8	68.0	73.2	69.5	73.2
630	65.6	63.7	65.6			
800	64.8	64.0	64.8			
1000	62.8	62.8	62.8	68.1	67.9	68.1
1250	61.8	62.4	61.8			
1600	62.0	63.0	61.9			
2000	59.5	60.7	59.3	64.9	66.1	64.8
2500	58.3	59.6	58.0			
3150	57.1	58.3	56.6			
4000	57.7	58.7	56.9	62.5	63.4	61.6
5000	58.5	59.0	57.2			
6300	56.8	56.7	54.8			
8000	55.4	54.3	52.5	60.6	59.6	57.7
10000	55.0	52.5	50.6			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 100.2 dB OASLA = 77.0 dB(A)

OASLC = 93.8 dB(C) C-A VALUE = +16.7

Figure 29: Hill AFB Depot Armament Repair Building.
Measurement Location: Main Bay – Outside of Steam Cleaner Curtain.
Measurement Conditions: Steam Cleaning Normal Operation.

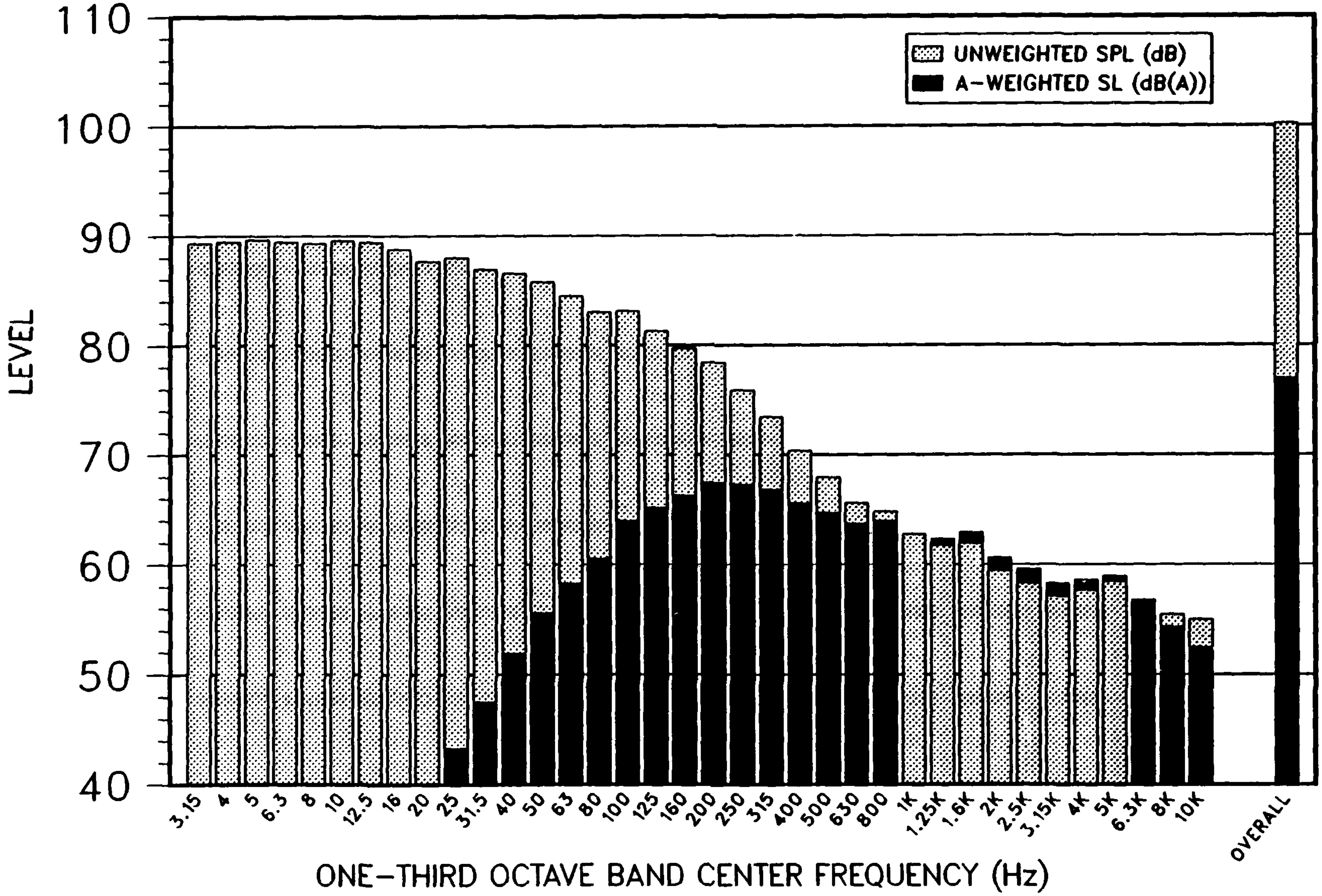


Table 30: Hill AFB Depot Armament Repair Building.
Measurement Location: Main Bay - Center of Section 1
Near Administration Area.
Measurement Conditions: Normal Operation with Steam
Cleaner Running.

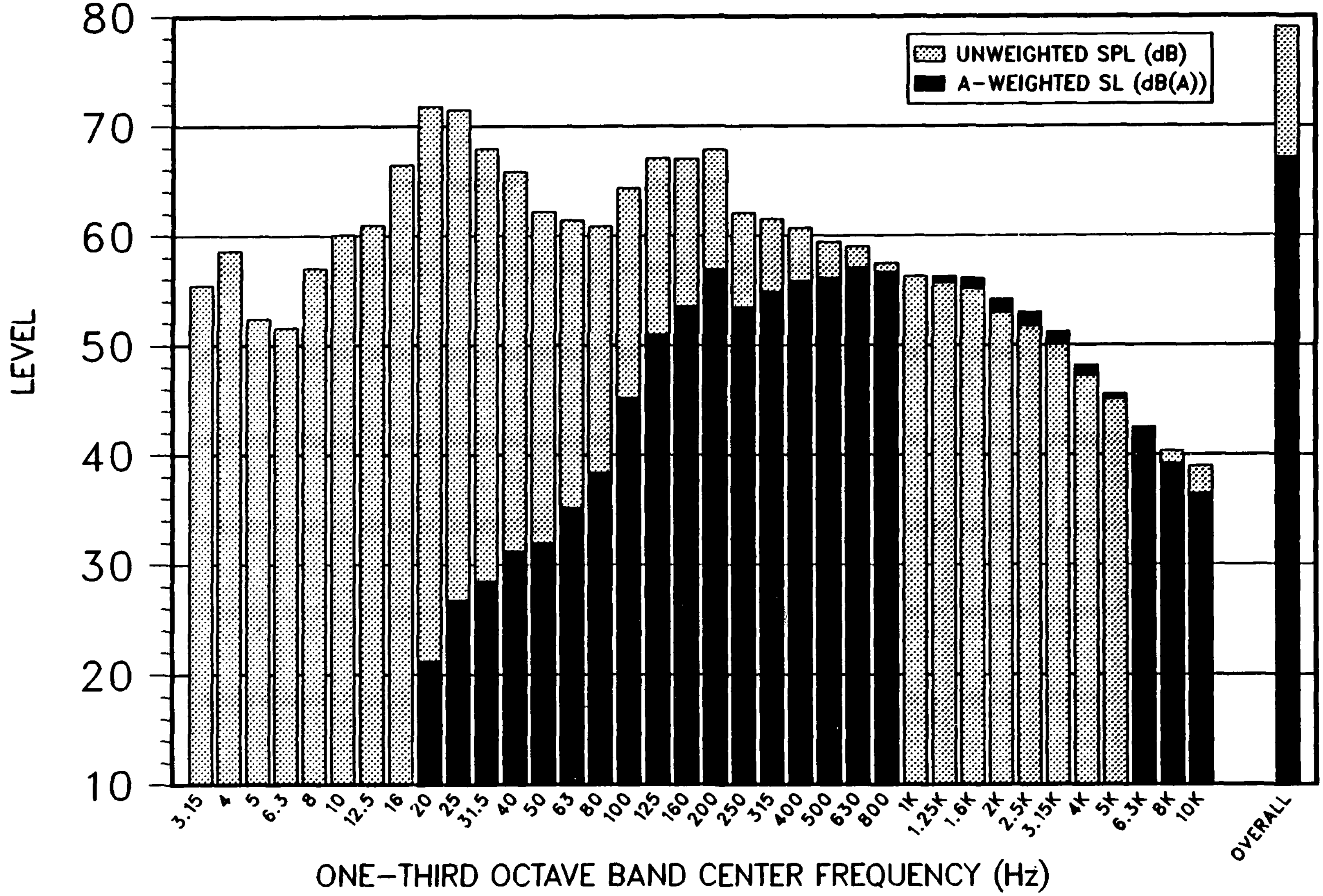
FREQ (Hz)	SOUND PRESSURE LEVEL (dB)	A-WT SOUND LEVEL [dB(A)]	C-WT SOUND LEVEL [dB(C)]	OCTAVE BAND SPL (dB)	A-WT OCTAVE BAND SL [dB(A)]	C-WT OCTAVE BAND SL [dB(C)]
3.15	55.4	0.0	0.0			
4	58.7	0.0	0.0	61.0	0.0	0.0
5	52.4	0.0	0.0			
6.3	51.6	0.0	0.0			
8	57.1	0.0	0.0	62.2	4.8	45.8
10	60.1	0.0	45.8			
12.5	61.0	0.0	49.7			
16	66.4	9.7	57.9	73.2	21.6	66.4
20	71.8	21.3	65.6			
25	71.5	26.8	67.1			
31.5	67.9	28.5	64.9	73.8	34.0	70.3
40	65.8	31.2	63.8			
50	62.2	32.0	60.9			
63	61.4	35.2	60.7	66.3	40.7	65.4
80	60.9	38.4	60.4			
100	64.3	45.2	64.0			
125	67.1	51.0	66.9	71.1	55.9	70.9
160	67.0	53.6	66.9			
200	67.8	57.0	67.8			
250	62.1	53.5	62.1	69.6	60.1	69.6
315	61.5	54.9	61.5			
400	60.7	55.9	60.7			
500	59.4	56.2	59.4	64.5	61.2	64.5
630	59.0	57.1	59.0			
800	57.5	56.7	57.5			
1000	56.3	56.3	56.3	61.3	61.2	61.3
1250	55.7	56.3	55.7			
1600	55.1	56.1	55.0			
2000	53.0	54.2	52.8	58.3	59.4	58.1
2500	51.7	53.0	51.4			
3150	50.0	51.2	49.5			
4000	47.2	48.2	46.4	52.7	53.7	52.0
5000	45.0	45.5	43.7			
6300	42.5	42.4	40.5			
8000	40.3	39.2	37.3	45.6	44.8	42.9
10000	39.0	36.5	34.6			

OVERALL LEVELS (3.15 - 10000 Hz)

OASPL = 79.0 dB OASLA = 67.2 dB(A)

OASLC = 76.5 dB(C) C-A VALUE = +9.4

Figure 30: Hill AFB Depot Armament Repair Building.
Measurement Location: Main Bay – Center of Sec #1 Near Admin Area.
Measurement Conditions: Normal Operation with Steam Cleaner On.



(This page left blank)

APPENDIX D

PREFERRED SPEECH INTERFERENCE LEVELS (PSIL)

(This page left blank)

Preferred Speech Interference Levels

SHEET METAL REPAIR

Measurement Conditions	Octave Band Center Freq (Hz)	Octave Band Sound Pressure Level (dB)	PSIL (dB)
Background Noise Near South End of Room	500	68.0	61.9
	1000	62.8	
	2000	61.4	
	4000	55.4	
Operator's Ear Position with Riveting Noise	500	81.8	86.3
	1000	88.9	
	2000	86.1	
	4000	88.4	
Middle of Room with Riveting Noise	500	72.7	75.3
	1000	74.7	
	2000	74.1	
	4000	79.8	
North End of Room with Riveting Noise	500	71.4	73.7
	1000	79.4	
	2000	73.7	
	4000	70.4	
Background Noise Near North End of Room	500	68.8	63.3
	1000	65.7	
	2000	62.4	
	4000	56.2	

Preferred Speech Interference Levels

GUN REPAIR

Measurement Conditions	Octave Band Center Freq (Hz)	Octave Band Sound Pressure Level (dB)	PSIL (dB)
Aisle #1	500	60.8	60.1
	1000	60.3	
	2000	60.2	
	4000	59.0	
Aisle #2	500	62.6	57.9
	1000	59.7	
	2000	56.8	
	4000	52.5	
Aisle #3	500	63.4	59.4
	1000	61.1	
	2000	58.7	
	4000	54.2	
Aisle #4	500	61.4	59.1
	1000	60.6	
	2000	58.5	
	4000	55.8	

Preferred Speech Interference Levels

F-4 SEAT REPAIR

Measurement Conditions	Octave Band Center Freq (Hz)	Octave Band Sound Pressure Level (dB)	PSIL (dB)
Background Noise Under Normal Operation	500	64.5	62.5
	1000	62.8	
	2000	60.1	
	4000	62.7	

F-16 SEAT REPAIR

Measurement Conditions	Octave Band Center Freq (Hz)	Octave Band Sound Pressure Level (dB)	PSIL (dB)
Background Noise Under Normal Operation	500	60.4	53.7
	1000	54.2	
	2000	51.8	
	4000	48.3	

ALCM REPAIR

Measurement Conditions	Octave Band Center Freq (Hz)	Octave Band Sound Pressure Level (dB)	PSIL (dB)
Background Noise Under Normal Operation	500	54.1	52.7
	1000	54.9	
	2000	54.4	
	4000	47.4	

Preferred Speech Interference Levels

MAIN BAY

Measurement Conditions	Octave Band Center Freq (Hz)	Octave Band Sound Pressure Level (dB)	PSIL (dB)
Section #1	500	69.4	62.3
Background Noise	1000	63.6	
Near North End	2000	61.1	
	4000	55.1	
Section #2	500	65.9	61.3
Background Noise	1000	63.0	
w/o Air Wrench	2000	60.6	
	4000	55.6	
Section #2	500	67.2	67.2
w/Air Wrench	1000	66.5	
Operating	2000	67.7	
	4000	67.5	
Section #3	500	67.7	63.3
Background Noise	1000	66.4	
w/Paint Booth	2000	62.5	
Operating	4000	56.5	
Section #4	500	69.2	65.1
Background Noise	1000	67.7	
w/Paint Booth	2000	64.0	
Operating	4000	59.3	

APPENDIX E

ACOUSTIC MATERIAL SUPPLIERS

(This page left blank)

List of Manufacturers of Acoustic Materials and Products

Industrial Noise Control, Inc.
1411 Jeffrey Drive
Addison, IL 60101
Phone: (312) 620-1998

The Proudfoot Company, Inc.
P.O. Box 1537
Greenwich, CT 06836
Phone: (203) 869-9031

E-A-R Division
Cabot Corporation
7911 Zionsville Road
Indianapolis, IN 46268
Phone: (317) 872-1111

American Sprayed Fibers, Inc.
1540 East 91st Drive
Merrillville, IN 46410
Phone: (219) 769-0180

(This page left blank)

APPENDIX F

BOLT BERANEK AND NEWMAN REPORT

(This page left blank)

Bolt Beranek and Newman Inc.

Report No. 4655

Industrial Noise Control Consultation to Oklahoma City Air Logistics Center (AFLC), Tinker Air Force Base

Richard C. Potter, Charles R. Jokel, Marianna J. Thorpe, and Paul Jensen

November 1981

Prepared for:
EAL Corporation

Report No. 4655

INDUSTRIAL NOISE CONTROL CONSULTATION TO OKLAHOMA CITY AIR LOGISTICS CENTER (AFLC), TINKER AIR FORCE BASE

Richard C. Potter
Charles R. Jokel
Marianna J. Thorpe
Paul Jensen

November 1981

Prepared for:

EAL Corporation
2030 Wright Avenue
Richmond, California 94804

Prepared by:

Bolt Beranek and Newman Inc.
50 Moulton Street
Cambridge, Massachusetts 02238

USAF Contract No. F33615-80-D-4003

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) INDUSTRIAL NOISE CONTROL CONSULTATION TO OKLAHOMA CITY AIR LOGISTICS CENTER (AFLC), TINKER AIR FORCE BASE		5. TYPE OF REPORT & PERIOD COVERED Task
		6. PERFORMING ORG. REPORT NUMBER 4655
7. AUTHOR(s) Richard C. Potter, Charles R. Jokel, Marianna J. Thorpe, Paul Jensen		8. CONTRACT OR GRANT NUMBER(s) F33615-80-D-4003
9. PERFORMING ORGANIZATION NAME AND ADDRESS Bolt Beranek and Newman Inc. 50 Moulton Street Cambridge, MA 02238		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 0005
11. CONTROLLING OFFICE NAME AND ADDRESS OEHL, Brooks AFB San Antonio 78235		12. REPORT DATE November 1981
		13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Capt. Elmore

2 – EAL Corporation

12 plus 3 reproducable – OEHL

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Industrial Noise

Noise Control

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes a noise consultation to the Oklahoma City ALC. Noise exposure, source mechanisms, noise control recommendations, and the benefits of noise control are described for thirteen industrial areas to meet the requirements of DOD Instruction 6055.3, June 1978, to protect the hearing of the employees.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

TABLE OF CONTENTS (Cont.)

TABLE OF CONTENTS (Cont.)

TABLE OF CONTENTS (Cont.)

4.1 Pneumatic Tools

A great variety of hand held pneumatic tools are used on the base, both in the shops surveyed during this project and at other locations. This section of the report addresses the general problems associated with their use, identifies their main mechanisms of noise generation and suggests a plan of attack that may be applied by all shops in order to reduce their noise contribution.

4.1.1 Problem Overview

Pneumatic tools are used in a variety of metal fabrication applications. Depending on the work process required their generic names may be grinders, chippers, scalers, needle guns, sanders, wrenches, drivers, etc. In each of these categories the tools may vary in size, power and rpm.

Operationally the tools have several common denominators; they are typically lightweight, easy to transport from location to location and simply-driven by connecting to a high pressure air line available throughout the facility. Because of these characteristics they are widely used. Acoustically they present, in most cases, a severe noise problem due to the high level of sound energy generated. The noise generated affects the operator and work stations in the near vicinity. Depending on their numbers and frequency of use they may be responsible to a large extent for the noise exposure problem in some shops.

Due to the great variety of the type, make, model and age of the tools present on the base it would be impractical to address the problem and solution for each individual pneumatic tool. Instead a general approach that may be applied to reduce their contribution to the noise exposure problem is made. This

approach together with the supportive information provided will allow base personnel to implement a comprehensive pneumatic tool noise reduction program.

4.1.2 Noise Source Mechanisms

With most hand held pneumatic tools, two mechanisms are mainly responsible for the noise generation. These are:

1. Air Exhaust
2. Workpiece Radiation

In the first case, high pressure air is used to drive an eccentric rotor inside a cylinder. The air expands as the rotor turns and is eventually discharged from the exhaust port. The high air velocity coupled with a high pressure drop across the exhaust is responsible for the generation of noise.

In the second case, the tool operation is translated into vibrational energy in the workpiece. This energy is propagated throughout the workpiece and radiated as noise to the surrounding space.

The success and type of the controls used depends on the correct diagnosis of which of the above two sources controls the overall noise. To accomplish this, there is a simple test which can be performed by most safety or health personnel on base. This consists of measuring the noise level (in dBA) generated by the operation of the tool on a workpiece under normal operating conditions. This first test will yield the overall noise level generated by both the exhaust and workpiece radiation. Next, the test is repeated while operating the tool against a rag bed on a rubber pad in the case of percussive tools like chippers or scalers, or against a small steel plate on a rubber pad (maximum 12"x12", - at least 1/2" thick) for abrasive tools like grinders or sanders. The second test will yield the contribu-

tion of the tool's exhaust noise under load since workpiece radiation is no longer a factor. The difference between the two measurements will yield the workpiece contribution.

1. If the difference between the overall noise level, (L_T) and tool exhaust noise level, (L_E) is 10 dBA or more, then the process is dominated by workpiece radiated noise (L_W). The workpiece noise level can be obtained from the following:

$$L_W = L_T \quad \text{(dBA)}.$$

2. If the difference between the overall noise level, (L_T) and the tool exhaust noise level, (L_E) is 6 to 9 dBA, then the workpiece radiated noise level (L_W) can be calculated from the following:

$$L_W = L_T - 1 \quad \text{(dBA)}.$$

3. If the difference between the overall noise level, (L_T) and the tool exhaust noise level, (L_E) is 4 to 9 dBA, then the workpiece radiated noise level, (L_W) can be calculated from the following:

$$L_W = L_T - 2 \quad \text{(dBA)}.$$

4. If the difference between the overall noise level, (L_T) and the tool exhaust noise level, (L_E) is 3 dBA, then the workpiece radiated noise level, (L_W) can be calculated from the following:

$$L_W = L_T - 3 \quad \text{(dBA)},$$

   in this case, both the exhaust noise level and workpiece noise level are equal.

5. If the difference between the overall noise level, (L_T) and the tool exhaust noise level is 1 or 2 dBA, then the workpiece radiated noise level, (L_W) can be calculated from the following:

$$L_W = L_T - 6 \quad \text{(dBA)}.$$

6. If the difference between the overall noise level, (L_W) and the tool exhaust noise level, (L_E) is 0 dBA, then the workpiece noise may be approximated by the following:

$$L_W < L_T - 10 \quad \text{(dBA)}.$$

Control of pneumatic tool air exhaust noise is only <u>effective</u> when cases 4, 5, and 6 are true. These cases cover the conditions when exhaust noise is the dominant source (6,5) or when exhaust noise is equal to workpiece radiation (4). Little or no effect on the overall noise level reduction will be achieved through tool exhaust noise control when cases 1, 2 or 3 are true.

Depending on the particular applications to which pneumatic tools are applied, any one of the above cases may be applicable. When using the retrofit procedures outlined in the next section, an attempt to identify which of the above cases best represents the work in a shop should be made. This is done by performing several tests in each shop to cover typical workpiece variability and tool applications. From these, the average case should be selected.

4.1.3 Pneumatic Tool Air Exhaust Noise Control

The basic approaches to pneumatic tool air exhaust noise control are:

1. Retrofit of existing tools with exhaust mufflers or piped-away exhausts,

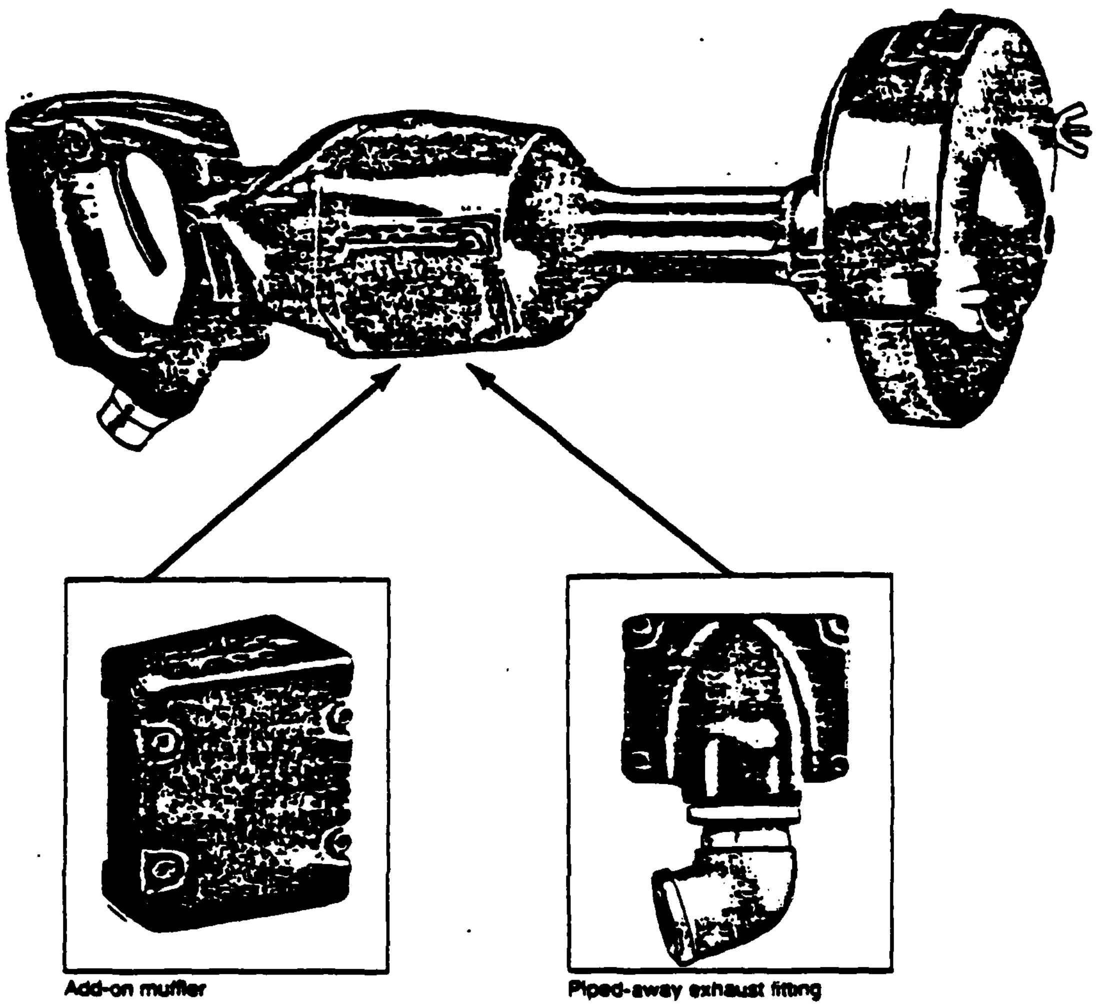
2. Specification and purchase of new tools with state-of-the-art noise control features.

In the first case, pneumatic tools which have been proven to benefit from air exhaust noise control (see Section 4.1.2) are outfitted with an exhaust muffler or piped-away exhaust kit. In some cases, these kits are available from the manufacturers. The range of muffler types and shapes available commercially for retrofit are illustrated in Figures 4.1 and 4.2. The mufflers shown on Figure 4.1 represent designs which can be bolted on to the body of the tool (a grinder in this case) and cover the air exhaust ports. This type of muffler could be fitted to a grinder which is unmuffled, or as a secondary muffler on to one already installed.

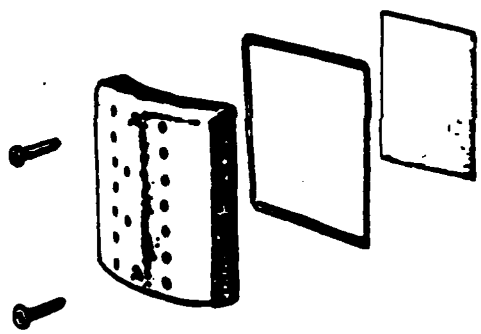
The alternative to a muffler fitted to the body of the tool is a piped-away exhaust with (or without) a muffler on the end of the hose. Figure 4.2(a) shows an exhaust hose fitted to a small horizontal grinder, with the hose concentric with the air inlet hose. For larger horizontal grinders with side exhausts, a hose fitting similar to that shown on Figure 4.2(a) would be required. A similar system can be used on vertical grinders as shown in Figure 4.2(b).

Table 4.1 summarizes* the makes, models and retrofit units available for some of the most <u>common</u> pneumatic tool types and manufacturers. It is recommended that the tool manufacturer be

*The list provided does not include all manufacturers who have retrofit kits available. In some cases the manufacturers listed have additional controls available beyond the ones listed. This summary is a listing of retrofit kits which have been identified by BBN to date under an ongoing study.

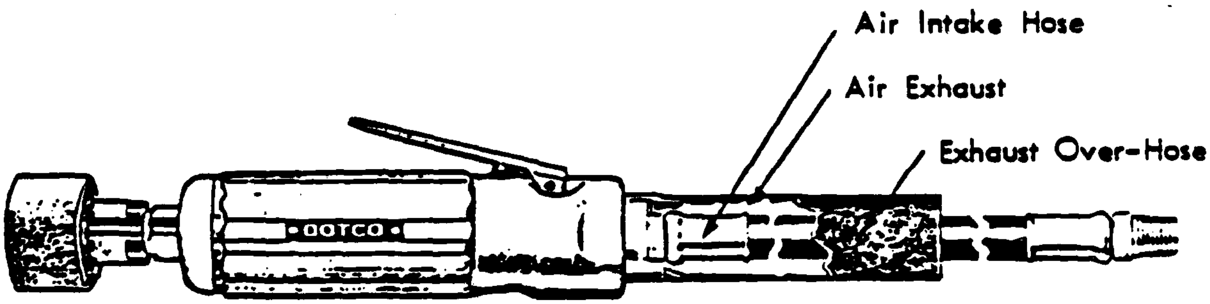


(a) Add-On Muffler Systems (Chicago Pneumatic)

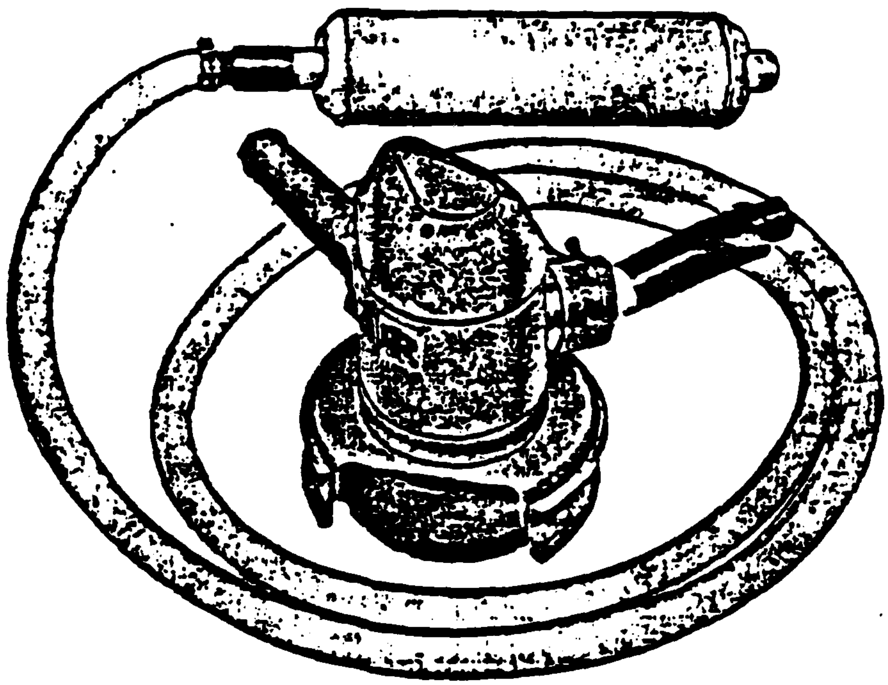


(b) Exploded View of Add-On Muffler (CLECO)

Figure 4.1 Examples of Commercially-Available Add-On Mufflers for Grinders



(a) Small Horizontal Grinder with Air Exhaust Hose (DOTCO)



(b) Vertical Grinder with Piped-Away Exhaust and Remote Muffler (Ingersoll-Rand)

Figure 4.2 Examples of Commercially-Available Exhaust Hoses and Mufflers for Grinders

always consulted as to the availability of retrofit kits from him or from approved muffler vendors. Installation of any exhaust muffler available which has not been tested for the particular tool in question may result in substantial performance deterioration and other operational problems.

4.1.4 Noise Reduction Through New Tools

In recent years tool manufacturers have become more responsive to the need for quieter tools. Thus the new models now available tend to have lower levels of tool noise than did their predecessors. Most tools are either inherently quieter, have built-in mufflers with improved acoustic performance, or have lightweight, piped-away exhausts and mufflers. From the performance and maintenance point of view, new tools with the built-in noise attenuation characteristics are preferable.

When purchasing new equipment, care should be taken to ensure that the tools have the lowest noise levels available. Several of the leading tool manufacturers now provide acoustic data on their products. In many cases, however, the data are provided for free-speed operation only. Free-speed noise levels are, in most cases, lower than those for loaded operation. Thus, when purchasing new tools, the acoustic performance should be judged solely on the loaded tool condition (when available). Free-speed noise levels should be accepted only as a last resort, and then these levels should be increased by about 5 dBA to reflect an estimate of the noise levels to be expected under loaded operation.

It is difficult to predict the noise reductions which will be achieved by the replacement of older tools with new designs, because the change is dependent on the particular tools discarded. However, it is estimated that, on the average, the noise reduction will be about 5 dBA relative to older models without

TABLE 4.1

Noise Control Retrofit Summary By Manufacturer

GENERAL SPECIFICATION DESCRIPTION	MODEL NO.	NOISE LEVEL dBA[1]	RETROFIT LEVEL dBA	RETROFIT COST $[2]	RETROFIT DESCRIPTION
MANUFACTURER: The ARO Corp.					
Drill, Pneumatic, 360 Deg. Head, 1/4" Cap. 2500 RPM	7439-D	86	80	42	Piped Exhaust System #37699
Drill, Pneumatic, Flat Angle, Reversible	7439-DS	84	80	42	Piped Exhaust System #37699
Drill, Pneumatic, Motor, 3/8" Cap. 500 RPM	7254-D	84	80	42	Piped Exhaust System #37699
Sander, Wet, Pneumatic, Right Angle, 1500 RPM	7945DW 7945EW	85 91	80 85	59 59	Piped Exhaust System #44561
Wrench, Nut Runner, Pneumatic 1/2" Hex Dr. Spec. Mod.	7453D	86	80	42	Piped Exhaust System #37699
MANUFACTURER: Chicago Pneumatic Tool Co.					
Wrench, Pneumatic, Impact 3/4"	CP-606-RTS CP-0606-1ESAB	L93 L93	L90 L90	15 15	Exhaust box for Piped-away Exhaust #C-126040
MANUFACTURER: Desoutter Inc.					
Wrench, Nut Runner, Pneumatic 1/2" Drive, Right Angle	SR10-160	>80	79	64	Silencer Assembly #203453
Wrench, Nut Runner, Pneumatic 1/2" Drive, Reversible	SR10-0-350	<84	79	64	Silencer Assembly #203453

[1] The noise levels reported are measured under a "free speed" condition unless preceded by the letter L - which designates an "under load" test. Both tests are in accordance with ANSI S5.1, 1971.

[2] The costs provided should be used only as a first order approximation. No shipping or installation costs are included.

TABLE 4.1 (Cont'd)

Noise Control Retrofit Summary By Manufacturer

GENERAL SPECIFICATION DESCRIPTION	MODEL NO.	NOISE LEVEL dBA[1]	RETROFIT LEVEL dBA	RETROFIT COST $[2]	RETROFIT DESCRIPTION
MANUFACTURER: DOTCO					
Grinder, Horizontal, Pneumatic 12,000 RPM w/ Erickson Chuck	10L3132A	81.5	78.5	10	Muffler #3032A (May already be installed on 1978 models)
	10L3132B	81.5	78.5	10	
Grinder, Horizontal, Pneumatic, Rear Exhaust, 18,000 RPM	10L1082	82.5	72.5	10	4 ft. Overhose #45-1-01A
	10L2082	83.5	77	10	4 ft. Overhose #45-1901A
Grinder, Horizontal, Pneumatic, Rear Exhaust, 25,000 RPM	10L1082	82.5	72.5	10	4 ft. Overhose #45-1901A
Grinder, Horizontal, Pneumatic, Rear Exhaust, 30,000 RPM	10L1080	87.5	85	10	4 ft. Overhose #45-1901A
Grinder, Rt. Angle, Pneumatic, 12,000 RPM	10-1200	89.5	85	25	Angle Head #1023 for tools prior to August 1974.
Grinder, Rt. Angle, Pneumatic, 20,000 RPM	10-1201A	89.5	85	25	Angle Head #1023 for tools prior to August 1974.
Grinder, Rt. Angle, Pneumatic, Rear Exhaust, 20,000 RPM	10L1281	87.5	85.5	10	4 ft. Overhose #45-1901A

[1]The noise levels reported are measured under a "free speed" condition unless preceded by the letter L - which designates an "under load" test. Both tests are in accordance with ANSI S5.1, 1971.

[2]The costs provided should be used only as a first order approximation. No shipping or installation costs are included

TABLE 4.1 (Cont'd)

Noise Control Retrofit Summary By Manufacturer

GENERAL SPECIFICATION DESCRIPTION	MODEL NO.	NOISE LEVEL dBA[1]	RETROFIT LEVEL dBA	RETROFIT COST $[2]	RETROFIT DESCRIPTION
MANUFACTURER: Ingersoll-Rand					
Grinder, Horizontal, Pneumatic 3000 to 4500 RPM, with Guard	35L45	F93 L102	F86 L102	85	Piped-Away Exhaust Kit No. R31-40G184
Grinder, Horizontal, Pneumatic 4600 to 8000 RPM, with Guard	21G60AZ	F85.5 L93	NA	78	Piped-Away Exhaust Kit No. R21-40G184
Hammer, Chipping, Pneumatic No. 2	2AD	L109	L108	50	Strap-on Muffler # HBW1-A674
	2AA 2SA	L109	L108	50	Strap-on Muffler # HBW1-A674
	2A	L109	L108	50	Strap-on Muffler # HBW1-A674
	W2A 2A	L109	L108	50	Strap-on Muffler # HBW1-A674
Hammer, Chipping, Pneumatic No. 3	3A 2SA	107	NA	50	Strap-on Muffler # HBW1-A674
Wrench, Torque, Impact, Pneumatic 1/2" sq. dr. 90 ft-lb	5040-T	NA	F75 L93		Piped Away Exhaust

[1]The noise levels reported are measured under a "free speed" condition unless preceded by the letter L - which designates an "under load" test. Both tests are in accordance with ANSI S5.1, 1971.

[2]The costs provided should be used only as a first order approximation. No shipping or installation costs are included

TABLE 4.1 (Cont'd)

Noise Control Retrofit Summary By Manufacturer

GENERAL SPECIFICATION DESCRIPTION	MODEL NO.	NOISE LEVEL dBA[1]	RETROFIT LEVEL dBA	RETROFIT COST $[2]	RETROFIT DESCRIPTION
MANUFACTURER: Rockwell					
Drill, Pneumatic Pistol, 1/4" Capacity, Right Angle, 2100 RPM	31A532C	82	79 79	65 10	Rear Exhaust Motor Housing OR Side Exhaust Muffler Ring (to be available shortly)
Drill, Pneumatic, 90 Deg. Head, 1/4" Capacity, 1600 RPM	31A533C	82	79 79	65 10	Rear Exhaust Motor Housing OR Side Exhaust Muffler Ring (to be available shortly)
Grinder, Horizontal, Pneumatmic, 3000 to 4500 RPM, with Guard	A	F96 L102	F89 L91	226	Exhaust Housing # 1021004 for tools prior to 1974.
Grinder, Horizontal, Pneumatic 20,000 RPM, with Guard	31051004	85	79	65	Rear Exhaust Motor Housing
MANUFACTURER: T. C. Service Co.					
Sander, Vertical, Pneumatic Portable, Light Duty, 4500 RPM	65VW	87	84	18	Muffler # 650-IM

[1]The noise levels reported are measured under a "free speed" condition unless preceded by the letter L - which designates an "under load" test. Both tests are in accordance with ANSI S5.1, 1971.

[2]The costs provided should be used only as a first order approximation. No shipping or installation costs are included

mufflers. It is possible that the new tools will generate similar noise levels to older designs fitted with mufflers.

Pneumatic tools whose noise exceeds the U.S. Air Force specifications, or are in excess of 90 dBA where no specification exists, should not be purchased. It is always more effective when buying a new tool, to purchase a model with the noise control options built into the tool by the manufacturer rather than to attempt control later on through retrofit.

4.1.5 Other Pneumatic Tool Noise Control Methods

The control of pneumatic tool generated noise is not limited only to the reduction in air exhaust noise through either retrofit or new tool acquisition. Control of this operation can also be achieved through:

a) workpiece radiated noise reduction, and,

b) operation separation from other noise sensitive areas.

Workpiece radiated noise can be reduced through a number of methods such as placing the workpiece on a non-resonant or absorbent surface, covering the workpiece with damping materials, etc. In many cases, these approaches are not practical due to the operational constraints or cost limitation. Due to these facts, the control of workpiece radiated noise can only be approached on a case-by-case basis and when applicable is treated on the individual shop basis. The control of pneumatic tool noise through separation means that other work areas are protected by the installation of barriers or screens between different work stations or by location of pneumatic tool operations away from other personnel or in open top enclosures. With this approach, the tool operator is not protected but other personnel positions affected by the noise are. As was the case previously, this approach needs to be evaluated on an individual shop basis, and is discussed there when applicable.

4.1.6 Pneumatic Tool Noise Control Strategy

A number of approaches to pneumatic tool noise control have been discussed in the previous sections. As a long term program that may be implemented on the base, the following recommendations are made:

1. On a shop-by-shop basis, measure and identify the situation where pneumatic tool air exhaust noise is predominant.

2. Identify the tool types and manufacturers which have retrofit kits available for the above.

3. Develop a systematic plan where all tools under steps (1) and (2) are retrofitted with exhaust mufflers or piped-away exhaust. This may be done in conjunction with the regular maintenance schedule or during tool repair activities.

4. All new tools purchased should have a noise specification included in the general specification. Pneumatic tools over 90 dBA should not be accepted except when no manufacturer has a "quiet" model available. (This may be the case for certain pneumatic tool types). When possible, noise data under a loaded condition should be sought for manufacturer comparisons. Recognizing that noise control technology is not available for all pneumatic tools a suggested noise specification should read as follows:

"Noise levels generated by the tool must be stated in terms of "A-weighted" sound levels (dBA). Noise measurements must be made in accordance with ANSI S5.1, 1971 Standard (CAGI-PNEUROP Code for the Measurement of Sound from Pneumatic Equipment). Tools without a noise level measured "under load" or "free running" will not be acceptable. When applicable under the standard, noise levels "under load" are preferred. Tools with noise levels of 90 dBA or less measured "under load" are desired. Tools with noise levels above 90 dBA measured "under load" or "free running" will be considered".

5. The use of workpiece radiated noise control should be implemented at each shop level as specified.

6. The use of barriers or screens or the relocation of pneumatic tool operations away from noise sensitive areas or in open top enclosures should be followed as specified for each shop.

(This page left blank)

Distribution List

	Copies
USAF Hosp Hill/SGB Hill AFB UT 84056-5300	5
HQ AFLC/SGBE Wright-Patterson AFB OH 45433-5001	1
AAMRL/BB Wright-Patterson AFB OH 45433-6573	2
HQ AFLC/SG Wright-Patterson AFB OH 45433-5000	1
HQ AFSC/SGPB Andrews AFB DC 20334-5000	1
HQ USAF/SGPA Bolling AFB DC 20332-6188	1
USAF Regional Medical Center Wiesbaden/SGB APO New York 09220-5300	1
OL AD, USAFOEHL APO San Francisco 96274-5000	1
HQ HSD/EV Brooks AFB TX 78235-5000	1
USAFSAM/EDH Brooks AFB TX 78235-5301	1
USAFSAM/TSK Brooks AFB TX 78235-5301	1
Defense Technical Information Center (DTIC) Cameron Station Alexandria VA 22319	2